Human Scent Evidence

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Preface

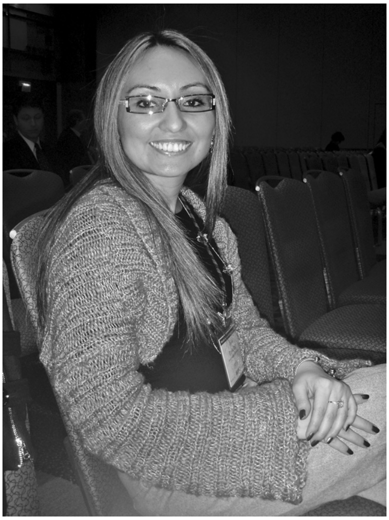
The reliable detection and courtroom acceptance of human scent traces as evidence is one of the last frontiers in forensic science. Since the 19th century, fingerprints have been used as a biometric to identify the individual who left the latent print or impression print at a crime scene. Since the 20th century, DNA from biological traces has been the gold standard in associating an individual with a crime scene. In the 21st century, the use of human scent as a biometric has the potential to place an individual at a crime scene as well as indicate where the individual went when leaving the scene. Very careful criminals may be able to leave a crime scene without leaving behind fingerprints, hairs, or other trace evidence but it is virtually impossible for an individual to not leave behind their scent even when briefly at a scene or when the scene is subjected to extreme events such as fires and explosions. At present, the use of human scent as forensic evidence is only possible with the assistance of specialized canines but as technology advances, instrumental confirmation of such matches should increasingly become a reality. Unfortunately, the use of specialized human scent identification canines has not significantly increased in recent years and, in fact, its use has decreased in many jurisdictions. This decrease is due to diminishing resources since the global recession in 2009, combined with increasing demands for scientifically validated studies to support the capabilities of these canines before they are deployed. During the last decade, there has been a significant number of scientific studies published which support the validity of using human scent as a biometric tool and indicator of the presence or absence of an individual's human scent at a scene as well as for conducting scent identification line-ups with suspects. This book focuses on some of these recent advances in the use of human scent as forensic evidence including selected examples from North America, South America, and Europe. Topics covered include a historical perspective, the production and transport of human odor, the chemical composition and laboratory confirmation of human scent matches/exclusions, the collection and storage of human scent, the persistence of and stability of human scent, the current methods of application of human scent canines, and the possibilities for future applications.

Acknowledgments

This book presents the work and experience of many individuals from organizations all over the world. Furthermore, the making of this book would not have been possible without the endless hours of laboratory work in the Furton research laboratory housed in the International Forensic Research Institute at Florida International University in Miami, Florida, which gave birth to an interesting area of study that has fostered innovative research areas. Deep gratitude is extended to fellow colleagues Drs. Jessica Brown, Lauryn DeGreeff, Davia Hudson-Holness, and Maiko Kusano for making this scientific research possible throughout different stages of the investigations of human scent from a chemical perspective. Appreciation also goes out to all the kind volunteers who donated their time for human odor samplings, and without whom this work would not have been feasible to conduct. Special recognition is also extended to Dr. Mario Rolando Rosillo, director of the Scent Identification Investigative Unit (UIO) part of the Scientific Investigative Directory, Province of Corrientes Police—Argentina. He is also an expert witness for the odorology section, Criminalistics Department, Rio Negro Province Police—Argentina. His expertise in the area and his thorough discussions, experiments, protocols, and pictures allowed the presentation of this technique and its development in South America. The Finnish regulations and historical perspectives, as well as protocols and pictures, are cordially presented with the collaboration of Ilkka Hormila, an instructor from the Police College of Finland, Police Dog Training Center in Hämeenlinna, Finland. Many thanks to Lieutenant Colonel Mario Hernando Chavez Rodriguez and his team at the Alvaro Rojas Ahumada Canine Handler and Training Academy, National Police of Colombia, for their generous information on historical perspectives and photographs. In addition, U.S. canine handler colleagues Curtis Fish and William Kift contributed pictures, which were essential to the making of different chapters of this book. Drs. Fabiola Zuno and Alejandro Rios, as well as Megan Friesen and Claudia Sanchez, are thanked for reading (parts of) the book, and their generous contributions of suggestions, corrections, and illustrations. Last, a huge thanks to the main characters of this book—canines from all over the world who not only provide an essential detection system in a criminal setting, but who ultimately prove to be man's best friend.

The Authors

Paola A. Prada, Ph.D., is an intelligence community postdoctoral research fellow. She received a B.S. in chemistry, and a Ph.D. in chemistry with a forensic science concentration at Florida International University (FIU). Her postdoctoral studies have united interdisciplinary areas such as chemistry, animal behavior, and national security to address issues that are critical to effective intelligence and defense capabilities. She has worked extensively on developing instrumental methods for human odor identification for criminal investigations. Dr. Prada has also worked with canine scent detection in the context of optimizing odor collection techniques for scent training. She is the author or coauthor of 11 publications and more than 30 presentations in national and international forums in her short career path. She was the first undergraduate student to earn a Bachelor's with Honors degree in the Department of Chemistry and Biochemistry at Florida International University, and was the 2006 recipient of the Edward Whittaker Award for Outstanding Student Presentation in Forensic Science from Nova Southeastern University in Florida.



Kenneth G. Furton, Ph.D., is a professor in the Department of Chemistry and Biochemistry and Dean of the College of Arts and Sciences at Florida International University. He received a B.S. in forensic science at the University of Central Florida, a Ph.D. in analytical chemistry at Wayne State University, and completed postdoctoral studies in nuclear chemistry at the University of Wales, Swansea, United Kingdom. He was the founder and is now the Director Emeritus of the International Forensic Research Institute. At FIU, Dr. Furton has taught thousands of students and directed the research of more than 100 undergraduate and graduate students, and has been continuously funded for over two decades receiving more than $10 million in extramural grants to support his independent and collaborative projects. His research has focused on the canine and instrumental detection of accelerants, biotoxins, currency, drugs, explosives, and humans (dead and alive). He is the author or coauthor of more than 700 publications and presentations. He has given hundreds of invited talks at a variety of venues across the United States and around the world and his work has been highlighted in a variety of media formats including *The New York Times* Science Section, the *Smithsonian Magazine,* and *The Wall Street Journal*. Dr. Furton's expertise in forensic science has been sought by the legal system for which he has testified dozens of times as an expert witness in state and federal courts. Notable awards he has received include the 2005 FIU President's Council Outstanding University Professor Award and the 2008 Collegian Award from Wayne State University. He is an elected fellow of the American Academy of Forensic Sciences.

Introduction and Historical Perspectives

1

1.1 Introduction

According to the *Merriam-Webster* dictionary, scent is defined as (1) effluvia from a substance that affect the sense of smell as an odor left by an animal on a surface passed over, or a characteristic/particular odor, (2) a perfume, (3) power of smelling or detection. All of these descriptions certainly apply to regular uses of the word; however, the novelty of scent in the field of forensic science is the potential to identify individuals. Although if thought on a more personal level, it should not be as surprising. Who has not experienced a dog noticing his owner's presence with his keen sense of smell, even when the person is not visible in the vicinity? Evidently, humans possess a personal scent that characterizes the individual and is not necessarily visible to the naked eye, much less to a crime scene technician in a forensic investigation.

The use of human scent as a source of trace evidence for investigative purposes is experiencing a renaissance of valuable forensic research pivotal to law enforcement applications, specifically in the realm of canine detection tools. Various challenges have surfaced in courts of law across the world that question the validity and reliability of this technique that employs biological detectors to alert to human scent traces. There is a limited body of scientific literature which pertains to the specific human odor signatures a canine alerts to when it makes a positive scent match with a subject. The available scientific studies investigating the origin and definition of human odor have focused mainly on the composition of human sweat in relation to hygiene and biological pathways rather than a more general description of human body odor. Thus, the identification and characterization of key human odor volatiles plays an essential role in understanding human scent evidence as an individualizing physical trait. Anecdotally, we know that a dog can identify a human with great accuracy, knowing of course that odor plays a key role for this identification. However, we do not understand clearly how or what the dog is alerting to. It is common to think then, that because we do not understand a technique fully, it cannot be reliable or used in a court of law. Many techniques are thus underexploited in forensic science because of this gap in knowledge, one of them being human scent evidence. What is human scent evidence? What does it take to use it most effectively? How can it help a case? We will try to provide answers to some of these questions from both a scientific and practical approach.

This book discusses various factors and theories of human odor production, collection, preservation, analysis, and the legal significance of the results. It includes historical aspects of the use of human scent in practical police work, both among national and international law enforcement personnel. It also details important findings from our research group about the development of a "scent barcode" using primary odor compounds to distinguish individuals via instrumental techniques and the potential of its use as a biometric measure.

The latest information from experimental research is summarized and supported by an extensive literature review in the field of human odor generation pertaining to the variability, stability, and persistence of human scent. Current trends in scent collection techniques including devices, materials, and storage protocols are discussed. Chemical aspects of the evaluation of human scent are also presented including instrumental methods for odor detection and analysis. Human scent canine work is discussed including different search categories depending on the mission of the canine/handler team. The future direction of human scent evidence in the forensic field is described giving insights into its application as a biometric and diagnostic tool.

1.1.1 Principle of Human Scent as Trace Evidence

> The dust and debris that cover our clothing and bodies are the mute witnesses, sure and faithful, of all our movements and all our encounters.[*]
>
> **—Edmond Locard**

Before we begin the journey into the origins and studies of human scent, one must first understand the value of trace evidence in any criminal investigation. Forensic scientists utilize trace evidence to obtain as much information from the crime scene as possible. The physical evidence collected serves as unquestionable and scientifically sound data which are neutral proof of the facts being disclosed. The importance of physical evidence provides a degree of certainty which could establish important relationships in the course of a legal investigation. It could link a suspect to the crime scene or a victim to a suspect.[1] Perhaps the most important and basic foundation of forensic science is that found in Locard's exchange principle—every contact leaves a trace. Applied to a forensic investigation, at every crime scene the perpetrator of such a crime comes into direct contact with the scene, hence bringing something into the scene and leaving with something from the scene. Trace evidence items are the tools by which the analyst can help tell the story of what happened. These could include anything from glass, fibers, hairs, blood, semen, all the way to soil or biota. The trace is always there, but finding such evidence is limited to the abilities, knowledge, and techniques at the analyst's disposal.[2]

---

[*] Locard, E. (1930) The Analysis of Dust Traces. Part I. *The American Journal of Police Science*, 1:3, 276–298.

Human scent can also be utilized as a form of trace evidence yet it is sometimes overlooked by law enforcement personnel. Human scent is a form of trace evidence that cannot be seen or touched, but is always imparted to every surface and in every location where the individual of interest has been present. Establishing an association between the human scent traces left by a perpetrator at a crime scene to the human scent of the suspect of that crime is the basis for the use of human scent identification evidence in a court of law. The ability to establish such a relationship originates from the principle that every individual has a characteristic odor that can be used as a physical trait to distinguish and identify the person. With the help of a well-trained canine, human scent can allow the investigative team to follow a suspect directly from the crime scene, determine the direction of travel of the suspect, identify the suspect in a scent line-up procedure, identify a particular location by scent, or recover missing persons.[3] Law enforcement personnel gather this evidence through the collection of scent from the objects that a perpetrator may have handled during the execution of the criminal act. The collected human scent evidence is consequently presented to canines for identification procedures, comparing scent from the crime scene (or victim) to that of the suspect.

1.1.2 Human Scent Discriminating Canines: The Line-Up History

The use of police and military dogs has been of historical importance in many detection applications worldwide (Figure 1.1). One of the main uses of human scent discriminating canines is for suspect discrimination procedures in practical police work. As a tool in forensic applications and investigations, suspect discrimination only establishes a possible association between evidence and suspect, and by no means delineates that indeed the suspect committed the crime. Traditionally, the role of a canine is to select the odor in a line-up that matches the odor of the *corpus delicti*, which can then establish an association between both scents.[4] For example, human scent discriminating canines can match the odor from a weapon left behind at the crime scene to that of a metal tube held by the suspect of that particular crime. Back in 1887, George Romanes authored one of the first experimental studies summarizing the ability of dogs to discriminate. He tested the ability of his hunting dog to follow his scent under different circumstances. He performed

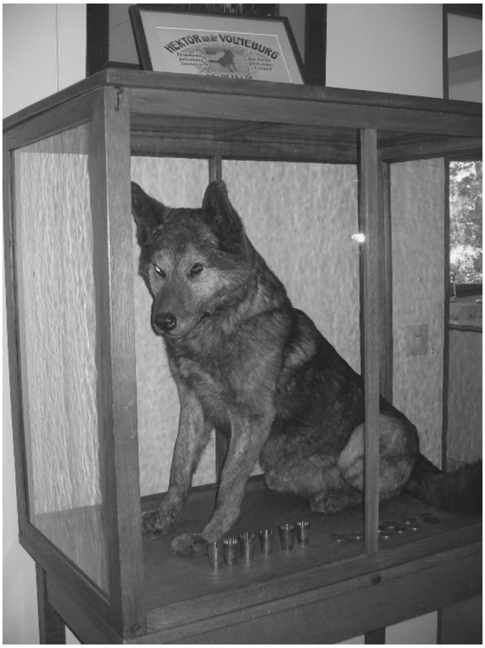


Figure 1.1 First police dog in Finland, Hektor von der Volmeburg, 1909. (Photo courtesy of Paola A. Prada, Police Dog Training Center, Hämeenlinna, Finland, June 2006.)

16 tests with other friends and servants walking in a park with, without, or with someone else's boots. Romanes deducted that the dog identified his scent trail "by the peculiar smell of my boots."[5] In practical police work, the first person to demonstrate the value of suspect discrimination with a canine as the biological detector tool was Inspector Bussenius from Germany in 1903. His canine was successfully used in a scent line-up using individuals as the scent source. The canine made a positive alert during two consecutive trials and led to the arrest of the suspect.[6]

A Working Dog's Oath

Author Unknown

I will lay down my life for you
And expect nothing but love in return.
I protect my officer with my life,
And would gladly take a bullet in his place.
I am sent in to find lost children
And fugitives on the run.
I find drugs and weapons and even bombs.
I am the first sent in

And sometimes the last to leave.
I am the nose and ears of my officer.
I will protect and serve him.
I would die for him and for you.
I only ask for compassion and a kind word.

The scent line-up, like any other technique, has witnessed a lengthy developmental process leading to its current status as an evidentiary tool. The most solid history of scent line-ups began as part of the Dutch National Police tracking canine school, back in 1919. In the early 1920s and 1930s, line-ups were performed with actual human subjects in the rows for identification. Line-ups gradually moved into using scented objects such as keys as scent sources for the canine to use for discrimination. Gradually, they progressed into using aluminum tubes as the scented object using similar procedures. In the latter part of this forensic development, the introduction of the stainless steel tube and the implementation of control checks during the line-up procedure have been seen. The current protocol is termed *check first* and consists of a two-row line-up method, consisting of seven odors each. The first trial is a control run, where the canine is tested by a positive identification to a control odor located in both rows. If properly identified, the canine is then scented to the *corpus delicti* to start the match with the suspect odor.[6] Figure 1.2 summarizes the evolution of the Dutch line-up methodology.

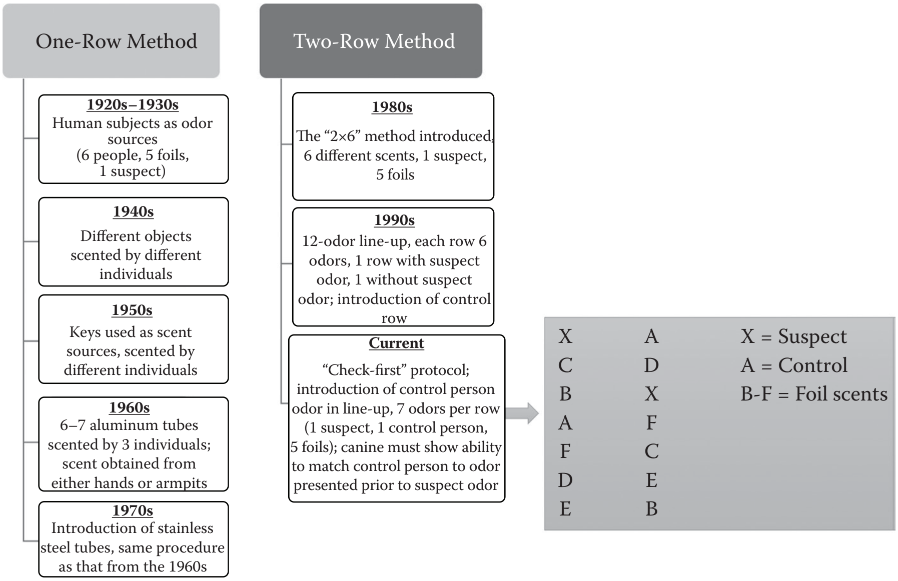

One-Row Method
Two-Row Method
1920s–1930s
Human subjects as odor sources (6 people, 5 foils, 1 suspect)
1940s
Different objects scented by different individuals
1950s
Keys used as scent sources, scented by different individuals
1960s
6–7 aluminum tubes scented by 3 individuals; scent obtained from either hands or armpits
1970s
Introduction of stainless steel tubes, same procedure as that from the 1960s
1980s
The "2×6" method introduced, 6 different scents, 1 suspect, 5 foils
1990s
12-odor line-up, each row 6 odors, 1 row with suspect odor, 1 without suspect odor; introduction of control row
Current
"Check-first" protocol; introduction of control person odor in line-up, 7 odors per row (1 suspect, 1 control person, 5 foils); canine must show ability to match control person to odor presented prior to suspect odor
X C B A F D E
A D X F C E B
X = Suspect
A = Control
B-F = Foil scents

Figure 1.2 Development of the scent line-up procedure. (Data adapted from Schoon A. and Haak R., 2002, *K9 Suspect Discrimination*, Canada: Detselig Enterprises Ltd.[6])

Even though the fundamental basis of a line-up is to match the odor of the perpetrator to that of a suspect, different countries conduct the procedure in different ways. The general method by which canine human scent line-ups have been performed can be separated by two major systems as is seen in Europe, the tube-retrieving system and the cloth responding system. The tube-retrieving system utilizes stainless steel bars or tubes and are mainly used in Western European countries where the suspect's human odor is collected on the tube by direct holding of the bar for a specified amount of time (usually 2 to 5 minutes). The tubes are 10 cm long and can either be placed on a platform where they are secured into position or placed loosely on the ground, depending on the particular country protocol. The canine is given a reference human odor, which may be an object collected from the crime scene, to which they consequently search for the matching human odor in the "line-up" of metal tubes. The canine then gives an active characteristic response whether this be scratching, biting, pulling, barking, or jumping next to the selected bar (see Figure 1.3).

In Eastern European countries (as well as South America), human scent evidence is presented to the canines by means of a "scented cloth" procedure. The pieces of cloth (typically cotton materials, i.e., gauze pads) are

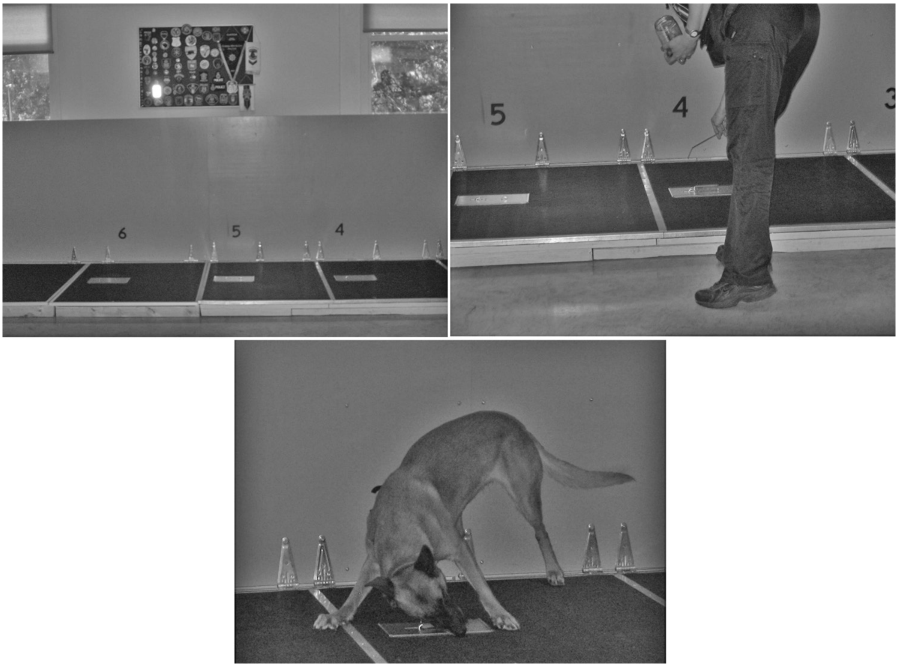


Figure 1.3 (See Color Insert.) Scent line-up identifications as conducted in Finland. (Photos courtesy of Paola A. Prada, Police Dog Training Center, Hämeenlinna, Finland, June 2006.)

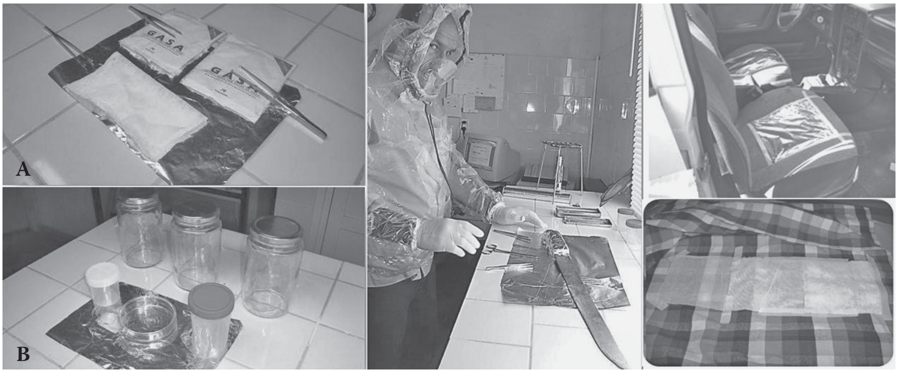


Figure 1.4 **(See Color Insert.)** Scent collection in Argentina: (A) cloth (gauze) material, (B) glass jars for storage. Scent collection from (C) knife, (D) car seat, (E) bed linens. (Photos courtesy of Dr. Mario R. Rosillo.)

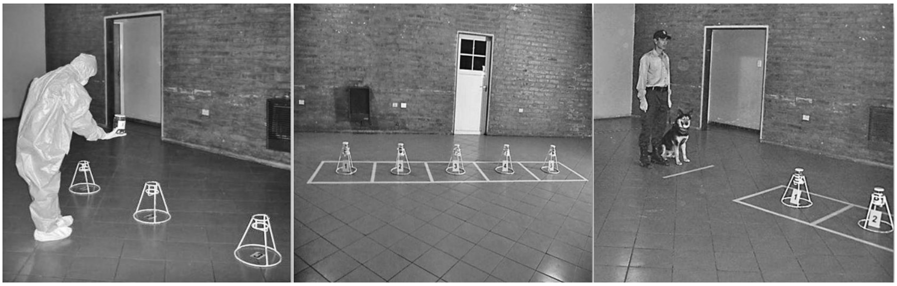


Figure 1.5 **(See Color Insert.)** Current scent identification line-up in the facilities at the canine unit in Rio Negro, Argentina. (Photos courtesy of Dr. Mario R. Rosillo.)

used to collect the emanating human odor handled by the suspect and from objects and/or locations from the crime scene, that is, car seats, weapons (see Figure 1.4). The length of scent collection prior to storage varies by agency standard operating procedures. These cloths are then placed in glass jars, which are consequently placed in human scent identification line-ups for the canine to perform a selection and matching of human odors (Figure 1.5). Usually, there are five jars in a row, although these can also be performed using 10 in a circle. However, this last setup is not that common. Unlike the training seen with the tube-retrieving system, which is governed by a reward-based system for the dog whose only drive is to obtain the tube, the cloth responding system is sometimes based on a food reward. The canines learn to stick their nose in the glass jars because in the initial phases of training there is food inside of the jars, and this is the reward for their search. Even though there is no food combined with the scent samples, the final reward in the line-up is food.[6] However, not all cloth responding procedures use a food reward, and in Argentina, for example, the reward is toy-driven such as a Kong®, which drops from above (approximately 30 cm from canine) so as not to cue the animal to the reward location. In some cases, and if the investigative team allows it, the canine is allowed to redo the line-up process to mark the response again, and the reward this second time is a toy plus praise.

1.1.3 Human Scent as a Forensic Tool: A Brief Historical Overview in Different Countries

> Every human being carries with him from his cradle to his grave certain physical marks which do not change their character, and by which he can always be identified—and that without shade of doubt or question.[7]
>
> **—Mark Twain**

The use of human scent as a form of indicative evidence is by no means a current trend. Our historical perspective can begin its traces back to 1896, where Austrian criminalist Hans Gross showed the potential of the canine as a detector system. He published a manual for investigators and law enforcement personnel where he reinforced the notion that a well-trained canine could efficiently find the trail of a fugitive and thus serve as an essential instrument in criminal work. Russia was one of the first European countries that used tracking dogs in 1906, and slowly introduced the technique to other Baltic regions (presently Poland, Estonia, Lithuania, and Finland) in 1907 near Saint Petersburg. Due to political and cultural differences, the investigations and experimental groundwork for human scent evidence remained secret and the large communication gap hindered its widespread use and scientific knowledge. Currently, human scent investigations continue to be used in countries such as Russia, Latvia, Belgium, Hungary, Holland, Finland, Denmark, Poland, Slovenia, Sweden, and Germany.[8]

In Poland, osmology, or scent identification studies, started in the criminalistics field in 1992. In 2000, there were approximately 36 laboratories dedicated to this area of study with 120 canines. Denmark had its first laboratory in 1992 as well, and in its first year had performed around 250 investigations. In Hungary, there are 21 scent evidence laboratories and around 53 trained canines. Finland started its first scent evidence investigations in 1999, using trained canines from Denmark. One of the first cases involved a knife recovered from a murder case, whose scent was sampled and given to the canine for suspect discrimination.[7] This started a formal collaboration with the Danish National Police in Denmark and the Netherlands National Police. Finnish officials would send about 10 cases (five to each unit) and due to the successful results, the Board of Directors from the Finnish police decided to embark on a 5-year project to start their own lab. According to fellow colleague and expert canine handler/trainer Ilkka Hormila, he and three other trainers received all training and certification with the Netherlands National Police Agency while receiving help from the Danish National Police. These two police agencies guided the development of the Finnish scent discrimination program by providing feedback and analyzing their progress thru video demonstrations. Formally, they started with their own dogs in 2004. From 2004–2009, they had approximately 959 cases, with 71 recognitions. In 2010, there were three canines in use, two under training, and three handlers. These scent identifications were used as evidence in 42 cases in local courts, with six cases reaching the court of appeals.

Although Europe has a much more established history of human scent evidence, the Americas are also exploiting this investigative methodology. In 1989, Cuba embarked on the construction of a scent evidence laboratory, with the expertise of scientists who had visited the Soviet Union and who used the Russian scientific knowledge on the topic as the foundation to scent discrimination work. Initial experiments were conducted following the cloth responding system where cotton materials were being utilized for the collection of scent samples. In the early 1990s, the first canine runs were made in the 9th Unit of the Municipality of Arroyo Naranjo in the city of Havana. Shortly after, the practice got extended to the rest of the country as a criminal investigation method. In 1995, Cuba opened a “scent bank” for the proper storage of collected scent samples thereby opening the door to widespread research in the field of scent evidence handling, storage, theory, and practice protocols.[9]

In South America, scent evidence was introduced in Argentina by Dr. Mario Rolando Rosillo in 1986. At the time, he was chief of the canine division of the Corrientes Police, a province in Argentina. As a veterinary doctor, along with his extensive work on canine ethology, he has greatly pushed the value of scent evidence in Latin America. In 1987, he presented the technique at the National Police Scientific Techniques Forum in the province of Neuquen, thereby giving the method the name of “human scent identifying canines.” In 1999, Dr. Rosillo traveled to Holland, where he encountered the technique of scent line-ups in criminal investigations as developed by the Netherlands National police. He returned to Argentina and gathered expertise from colleagues in the area of canine olfaction neurophysiology to gather a more profound understanding of the capabilities of dogs for discrimination purposes. In 2000, the use of human scent was officially used in the Canine Division of the Corrientes Police. Three canines were initially used for this purpose, Seeker (a Labrador Retriever), Kual (German Shepherd), and Combo (mixed race). This first experiment lasted 12 months, and after 9 months of controlled experimentation with the technique, the first legal investigation was conducted in the country. The canines were able to successfully identify the suspect of a homicide, who had handled a gun to commit

Figure 1.6 Dr. Mario Rosillo with "Panchi," a cadaver-detecting canine. (Photo courtesy of Dr. Mario R. Rosillo.)

the crime. In 2003, Dr. Rosillo moved to the city of Viedma, a province in Rio Negro, where he officially implemented human scent evidence as an active evidentiary tool in judiciary processes. Since 2004, human scent investigations have been performed not only in this province, but throughout the entire country. With the help and experience of Dr. Rosillo (Figure 1.6), who has imparted various workshops at other police agencies, the use of this valuable forensic tool is expanding its horizons in Latin America.[10]

The United States has also been developing the technique of scent evidence as an aid to criminal case work. As opposed to its European counterparts, however, the United States does not have formal scent line-up facilities in every state and local police department. However, the Federal Bureau of Investigation (FBI) has adopted the Dutch guidelines for their training methods with regard to formal scent line-up procedures within their facilities.[11] Furthermore, professional organizations in the United States such as the Scientific Working Group on Dog and Orthogonal detector Guidelines (SWGDOG) have helped to establish best practices by bringing together worldwide experts in the field. In addition to line-up procedures, the United States has implemented innovative ways for the collection of scent samples and has differed from the protocols established by the canine teams used in Europe. The use of human scent discrimination canines in the United States follows the same assumptions that every individual carries a distinct odor that differentiates him/her from the population. However, the collection of human scent in the United States has employed the use of airflow devices,

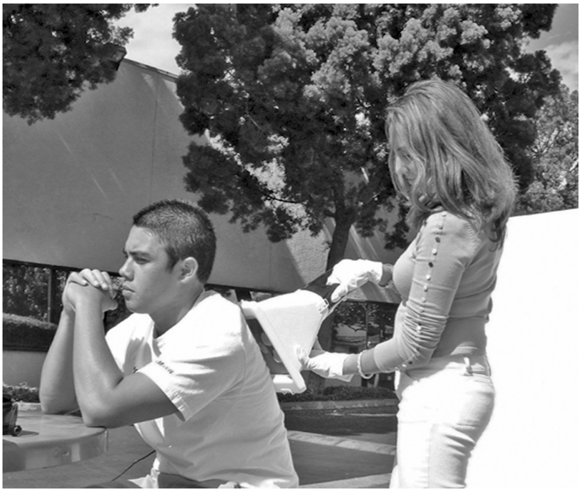


Figure 1.7 **(See Color Insert.)** Scent pad creation via the STU-100. (Photo courtesy of Paola A. Prada.)

namely the use of the Scent Transfer Unit (STU-100)[12] (see Figure 1.7). After making scent pads from the object or person of interest, the canine handler can then proceed to present these pads to the canine for location checking or suspect discrimination purposes. The FBI human scent evidence team (HSET) was established in 2002 and is a full time program in the laboratory's evidence response team unit. After proper training and certification procedures, HSET dogs are called in from different jurisdictions throughout the country to aid investigators in a range of cases, from live missing victims to the search for decomposing bodies.

1.1.4 Human Scent Evidence in the Courtroom

As with any trace evidence, there are certain guidelines that establish if such facts or techniques can indeed be presented and used in a legal setting. In cases involving scientific and/or novel techniques, there are landmark cases that govern how reliable and relevant the evidence may serve in the criminal investigation. In 1923, the case of *Frye v. United States*[13] set forth a precedent for admitting scientific examinations in the courtroom. In this case, it was determined that in order to admit such testimony the technique, procedure, or principle must be generally accepted in the particular segment of the scientific community in which it belongs. Problems with the Frye standard were that it did not specifically delineate the field in which the methodology had to be accepted, and whether the technique or the theory itself were to be evaluated in the process. Hence, almost 70 years after Frye, the revolutionary case set forth in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[14] established the

Table 1.1 Examples of Expert Evidence Criteria in the Courtroom

Daubert Criteria	Shoeprint Criteria
Has technique/theory been tested?	What is the professional and educational background of expert?
Has technique/theory been subjected to peer review and publication?	Does expertise relate to the subject for which the expert is giving testimony?
What is the error rate of technique/theory being presented?	What is the method/technique expert used?
Are there any standards for quality control of its operation?	What is the reliability of the method/technique?
Does the technique/theory possess widespread acceptance in the scientific community?	Did the expert apply the method/technique in a reliable and competent manner?

Source: Data adapted from Broeders A.P.A., 2006, Of Earprints, Fingerprints, Scent Dogs, Cot Deaths and Cognitive Contamination—A Brief Look at the Present State of Play in the Forensic Arena, *Forensic Science International,* 159, 148–157.[16]

trial judges as “gatekeepers” in finding a sound judgment for the admission of scientific evidence. As suggestions to accomplish this goal, some points to consider are whether the scientific technique can be and has been tested, whether the technique has been subjected to proper peer review, the technique’s potential error rate, standards that control the technique’s operation, and whether such technique has gained acceptance in the scientific community. The Daubert “standards of evidence” increased the need for trial judges to have a thorough understanding of the theory and foundational principles surrounding the scientific findings being disclosed as expert evidence. While these landmark U.S. cases can be said to be some sort of preliminary examination or control (with the judge acting as gatekeeper), the Dutch legal system uses a sort of exit examination for evidence control. One of the most important decisions to monitor evidence reliability was seen in the Shoeprint decision,[15] where the Supreme Court not only ensured the experts’ experience and knowledge as qualifying markers, but also questioned the expert capabilities and qualifications in using the method, which closely resembles the U.S. Federal Rules of Evidence.[16] Table 1.1 summarizes the Shoeprint (Dutch) and Daubert (U.S.) criteria for admissibility of expert evidence to highlight key points courtrooms employ.

Canine scent evidence is admitted in the United States courts of law as expert witness testimony provided it satisfies the basic standards for the corresponding jurisdiction. Different court jurisdictions have brought up different aspects and challenges in using canine evidence in trial proceedings including the reliability of the canine team used and the subsequent acceptance of the scent identification as incriminating or exonerating evidence. Canine evidence is not only challenged as per the actual canine capabilities, but also in light of its diagnostic value and possible evidentiary use. As per the Scientific Working Group on Dog and Orthogonal detector Guidelines (SWGDOG), preliminary points to consider in establishing the reliability of a canine team involve: (1) establishing canine team preparation via maintenance training and certification records, (2) presenting canine team's deployment results, and (3) documenting the collection of scent evidence using appropriate chain of custody records. Maintenance training records should indicate discipline-related training, use of distracting stimuli, various training scenarios, use of negative or blank testing, operational experience, and proper canine certifications.[17]

Courts in the United States have seen the introduction of canine scent evidence since the beginning of the 20th century and, as demonstrated by case law, history has witnessed a lengthy process for its acceptance. Even though it is not the intent to provide a thorough case law review, it is important to highlight some specific cases that have helped canine scent evidence in different jurisdictions, at both national and state levels.

In *Hodge v. State*,[18] the state Supreme Court accepted testimony in regard to tracking dogs and the use of this type of evidence for jury consideration. The court acknowledged that dogs may be trained to follow human tracks with considerable certainty and accuracy. Three years later in *State v. Hall*,[19] the court addressed that in cases where bloodhound evidence was used, a full opportunity should be given to inquire about the breeding, training, and testing of the dog. Toward the end of the 1800s, it was accepted that bloodhound trailing evidence could provide an association between the defendant and the crime of which he was accused,[20] although in some states similar decisions were not achieved until the 1980s–1990s.[21–22]

Challenges in U.S. courtrooms regarding canine evidence did not subside, and, in 1903, some courts even called it "unsafe evidence." The Supreme Court of Nebraska pointed out that dogs are frequently right and frequently wrong in their conclusions, thus repudiating the suggestion that bloodhounds had any capacity for trailing.[23] In view of such circumstances, various cases that followed dictated important points for consideration with regard to canine evidence. Courts determined that prior to any dog tracking testimonies, the court must make preliminary investigations as to the reliability of the person testifying and the ability of the dog to scent such a track (power of discrimination), as well as proper testing by a knowledgeable person.[24–25] This was corroborated in *Cranford v. State*[26] where the court held that canines possessed qualities, accuracy, and training in trailing human beings. At the beginning of the 1920s, it was documented in additional cases that among other things canine evidence alone is insufficient to sustain a conviction and that it is the human testimony that makes the canine trailing competent.[27–28]

In more recent case law history, numerous trials have continued to use canine evidence in their legal proceedings. In a 1978 California case, a police dog was used to trail defendants from the interior of a stolen vehicle to the point of detention. The court stated that the abilities and reliability of each canine team used as evidence has to be considered on an individual basis and left to the discretion of the finder of the fact.[29] In the same year, an Arizona Court of Appeals reiterated that even though records of failure of a canine should be kept to substantiate the reliability of the dog, the defect alone does not make foundation insufficient.[30] Other points emphasized by different U.S. courts include the period of efficiency of a canine, which is defined as the period of time in which he has demonstrated that he could accurately follow a scent trail,[31] as well as the acknowledgement that there are other factors that can affect the reliability of evidence (i.e., atmospheric conditions, time lapse between commission of crime and tracking activities, number of people present in particular area, time of crime, and even how canine feels or behaves on particular day).[32] To further establish proper admissibility for general canine scent evidence, various U.S. court jurisdictions have adopted specific foundational elements. These elements include the handler's qualifications to use the dog, whether the dog is of a breed characterized by acute power of scent and has been trained and tested to track humans, the canine's reliability in pursuing human tracks, whether the location where the dog was placed is upon a trail made by the suspect, reasonable time, and whether the trail has not become contaminated or aged as to be beyond the canine's capacity to follow, as well as any other "indicia of reliability."[33–37]

The recent use of novel scent collection methodologies in the United States (i.e., Scent Transfer Unit, STU-100) has brought even more challenges to scent evidence in courts of law. In 2003, in *People v. Mitchell*, the introduction of scent evidence collected by the STU-100 was observed. Among critical points argued by the court, there was the notion that this type of evidence should have been excluded as there was no proper assessment of the reliability of the device or sufficient proof of the uniqueness of an individual's odor.[38] This was further upheld in *People v. Willis*,[39] in which the novelty of the STU was once again questioned and the lack of a proper scientific foundation as to the survivability and individuality of human odor were the main problems with the presented canine evidence. It was not until *People v. Salcido*[40] that the STU-100 and canine human scent evidence were admissible in court as long as the person utilizing the technique follows correct scientific procedures, the training and expertise of the canine team is proven to be proficient, and the methods used by the dog handler are reliable. Criminal investigations continue to use scent evidence taking advantage of the efficiency of canines as a biological detector tool. In *People v. Wade*,[41] the court denied the defendant's motion to exclude dog trail evidence. The court also documented that canine human scent evidence has limitations, such as the age of the trail, weather conditions, and the strength of the individual human scent. Applying the Daubert criteria, the *Wade* case showed that human scent evidence was based on scientifically valid principles supporting the government's contention that dogs can be trained to follow a unique human scent trail. As can be observed, every case has brought to the table different facets and challenges to be overcome in order to fully accept scent evidence as a valid and reliable forensic evidentiary tool.

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Production of Human Scent

2

2.1 Human Odor Formation

A pivotal part in comprehending the usefulness of human scent evidence in practical canine applications lies in an effort to understand the composition of body secretions that make it possible for dogs to identify people based on their odor. The sources of body odor contributing to an individual's "odor signature" are numerous. This human odor generation can be described as a combination of volatile compounds released from the body, which are directly affected by genetics, environment, gender, age, and physiologic body processes. Due to the diverse composition of odor-producing sources, it is important to review the different variables that together encompass and generate the complex odorant mixture ultimately referred to as human scent. The following sections will explore human scent from a physiological viewpoint depicting the influence of genetics on human odor, skin glandular activity as well as axillary odor research that together provide the building blocks as to the intricate definition of human odor as an individualizing characteristic.

2.1.1 Genetic Origin

Almost 40 years ago, Lewis Thomas first proposed that functions of the major histocompatibility complex (MHC) included recognition of self and nonself thus reflecting chemical sensory signaling of individuality in advanced taxa.[1] Seminal work by Brown[2] has reinforced this body odor chemical signaling in mammals. His work summarized that body odor provides information such as species, age, sex, kin membership, reproductive status, stress, and even individuality markers. The human major histocompatibility complex can be defined as a region of 4 Mb of DNA whose location is on the 6th chromosome made up of approximately 200 genes. The human MHC is referred to as the *Human Leukocyte Antigen* (HLA). This genetic region is found in other mammals, and in the mouse genome it is called the *H-2*. The MHC molecules can be divided into two main categories, Class I and Class II. Molecules in the Class I category are present in all nucleated cells within the body and their function is to process and allow recognition by T-cells of any present foreign antigens. Class II molecules of the MHC are present on certain lymphocytes and their purpose is to present antigens for recognition with other types of cells such as helper T-cells that increase the immune response.[3] The most prominent feature of the MHC complex is its genetic diversity. Four main characteristics linked to this diversity include: number of functional loci per class, allelopolymorphism, codominant expression, and a high level of heterozygocity.[4] Yamazaki and colleagues contributed to pioneering studies which showed that mice prefer odor of conspecifics different in the MHC genes.[5] Since then, an outburst of research has been published regarding MHC as a source of a unique personal "odortype" (recent reviews, Havlicek and Roberts; Kwak et al.).[6–7]

The manner in which the MHC genes influence the generation of body odor is still unclear, however, several hypotheses have been proposed (Figure 2.1). Since the MHC molecules are present in the urine and sweat, it is thought that perhaps they provide the odorants in this manner. This hypothesis is unlikely since MHC molecules are large, nonvolatile proteins and MHC determined odors are volatile. A second hypothesis states that these MHC molecules bind to allele-specific peptides and that their volatile metabolites (such as carboxylic acids) provide the odorants. In mice, for example, these peptides are nine amino acids. The determining factor in binding are the large hydrophobic side chains of particular amino acids, which occupy specific pockets in the MHC-binding region (groove).[8] An alternate theory suggests that MHC genes may affect odor by shaping specific populations of microbial flora. This hypothesis has been tested by rearing congenic rodents

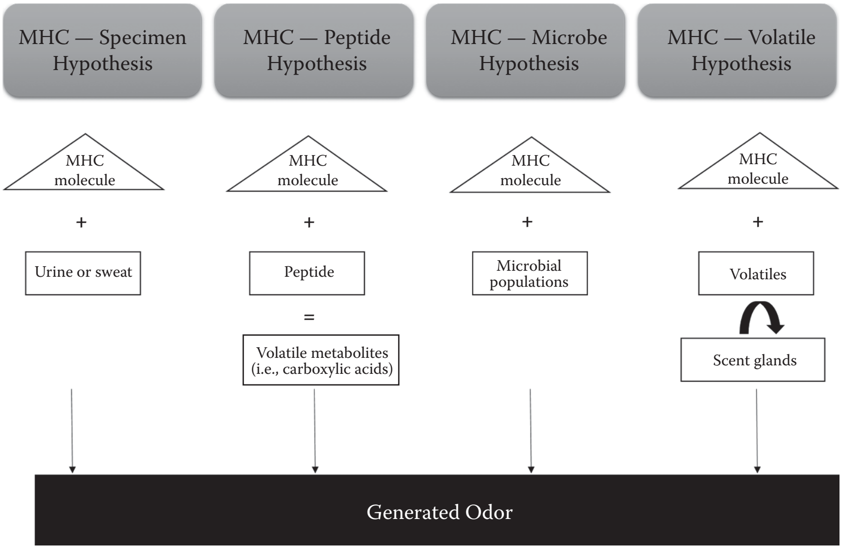

MHC — Specimen Hypothesis
MHC — Peptide Hypothesis
MHC — Microbe Hypothesis
MHC — Volatile Hypothesis
MHC molecule
MHC molecule
MHC molecule
MHC molecule
+
+
+
+
Urine or sweat
Peptide
Microbial populations
Volatiles
=
Volatile metabolites (i.e., carboxylic acids)
Scent glands
Generated Odor

Figure 2.1 MHC genes and hypothetical mechanisms of odor production.

in germ-free conditions, and it appears that the MHC type interacts with commensal bacteria to yield distinctive urine odors.[9] Another proposed mechanism has suggested that MHC molecules may change their conformation to bind volatiles, instead of peptides, and consequently carry them to the scent glands. Recent work has further corroborated this hypothesis by showing how human leukocyte antigen (HLA) genes are directly correlated with human skin volatiles and mosquito attractiveness.[10] In general, it can be summarized that MHC-dependent odorants are then direct degradation products of MHC molecules and/or peptides, metabolites of biochemical pathways, or some combination of all these mechanisms.[11]

Researchers have used genetically engineered mice to understand the role and mechanisms that mediate the effects of the MHC genes on body odor. Mouse urine has been a potent source of information on MHC haplotype, as it is a complex mixture of both low molecular weight compounds as well as peptides. The protein content is composed of major urinary proteins (MUPs) that act as carriers for volatiles contributing to the chemical signal.[12] Analytical chemical studies of urine fractions, from a variety of mouse strains, have shown that MHC-related volatile compounds can be differentiated based on concentration differences, not qualitative patterns, and that MHC genes influence the amount of testosterone-mediated pheromones and sulfur-containing compounds as well as several carbonyl metabolites.[13–14] Additionally, MHC-distinctiveness of odors has been studied through various behavioral assays of urine/serum odor using mice and rats as biological detectors. Together, these data have shown that the composition of the odor profile in the specimen shows some association with the MHC, and that consequently because patterns of odorants are similar in urine and serum, MHC-gene products bind to circulating odorants selectively well before renal processing.[3,15–17] In a study conducted by Schaefer et al.,[18] urine from male mice was used to monitor if body odor from genetically different mice donors caused distinctive responses in the neuronal activity of female odor recipients. The results showed that not only is the concentration of the spatial pattern of urine odor consistent enough to predict the H-2 haplotype of the urine donor, but also that urine odor from genetically different mice cause distinctive physiological responses in the main olfactory bulb.

Various studies have also focused on the link between body odor perception and the degree of allele sharing between individuals producing the odor and those smelling it. It has been concluded that in principle body odor can be described in such a way that through statistical methods it can be linked directly to the MHC. The perception of odor as it is related to the MHC can be described such that intense odors are perceived less pleasant if the donor and the receiver are of MHC-dissimilar type, but not if they are of MHC similar type.[19–21] Further work with monozygotic human twins has expanded the notion of a genetic contribution to body odor type, as shown by perceived human olfaction as well as specific patterns of odorant fatty acids in human axilla secretions.[22,23]

2.1.2 Human Skin

Due to the forensic interest of this book in the individuality of scent traces left on crime scene objects, locations, or victims, the human skin is key in the deposition of odor. Human skin is the largest organ of the human body. It is strategically located at the boundary between internal and external environments providing a protection medium to stress factors such as UV radiation, and chemical and biological contaminants. Human skin extends to approximately 2 m^2 in area and it is roughly 2.5 mm thick. It provides for 6% of an individual's total body weight. There is variation in skin characteristics such as thickness and composition due to age and body location. The temperature of human skin ranges from 30–40°C as a result of air temperature variation between 15–40°C. Skin temperature changes in response to both environmental and physiological fluctuations. The water content at the surface of the skin is directly related to the outside temperature. Surface moisture also depends on transepidermal water movement from the blood system to the surface as well as by regular sweating.[24]

2.1.2.1 Layering of the Human Skin

The human skin is made up of distinctive layers that allow this organ to perform its function as a permeable barrier to the human body. Each layer has a characteristic physical and chemical property according to its specific function. The human skin is also characterized by special types of cells that also have a key role in protecting the skin. The skin layers are composed of the epidermis, dermis, and the hypodermis (Figure 2.2).

The outermost layer of the human skin structure is the epidermis. Its composition is mainly of flattened cells. The top surface of the epidermis is commonly known as the stratum corneum. The horny cells found in this surface are flat, nonnucleated cells of a diameter of 40 μm and a thickness of 0.5 μm. The stratum corneum has approximately 15 layers. There is a lack of homogeneity in the stratum corneum due to various stages of cell formation and intercellular processes.[25]

The main types of cells found in the human epidermal layer are called *keratinocytes*, which consist of a protein called keratin. They give the skin surface its strength, resistance, and flexibility. Contained by the keratinocytes are filaments of keratin, which are embedded in a gelatin type of matrix whose layers make up the epidermis. Other types of cells commonly known as immigrant cells also make up part of the epidermis skin layer. These kinds of cells move to the skin from other body regions during early developmental stages in order to give physical and chemical protection to the skin. There

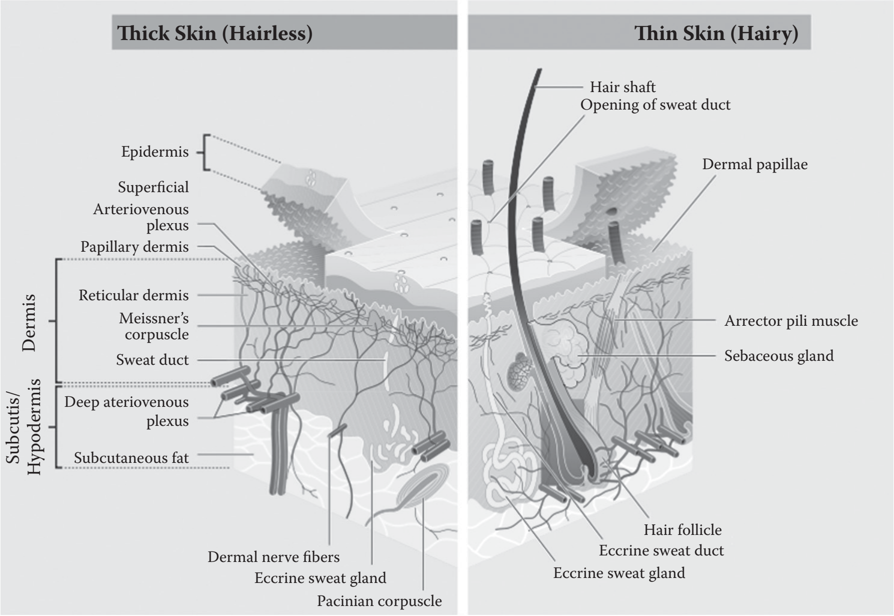

Thick Skin (Hairless)
Thin Skin (Hairy)
Epidermis
Superficial Arteriovenous plexus
Papillary dermis
Reticular dermis
Meissner's corpuscle
Sweat duct
Deep ateriovenous plexus
Subcutaneous fat
Dermis
Subcutis/ Hypodermis
Dermal nerve fibers
Eccrine sweat gland
Pacinian corpuscle
Hair shaft
Opening of sweat duct
Dermal papillae
Arrector pili muscle
Sebaceous gland
Hair follicle
Eccrine sweat duct
Eccrine sweat gland

Figure 2.2 **(See Color Insert.)** Schematic of human skin composition. (From "Skin," Wikipedia: The Free Encyclopedia. Wikimedia Foundation, Inc. May 7, 2014. Available at https://en.wikipedia.org/wiki/File:Skin_layers.png, accessed November 6, 2013.)

are three major types of cells in this immigrant cell category. Melanocytes generate the skin's main pigment and natural sunscreen, melanin. Another type of immigrant cells includes the Langerhans cells. These are specialized cells of the body's immune system that act against foreign substances coming in contact with the skin. Merkel cells are the third type of skin cell that are directly linked to the sense of touch. Also, within the epidermal layer are free nerve endings that allow for information from the external environment to be processed.[23,26]

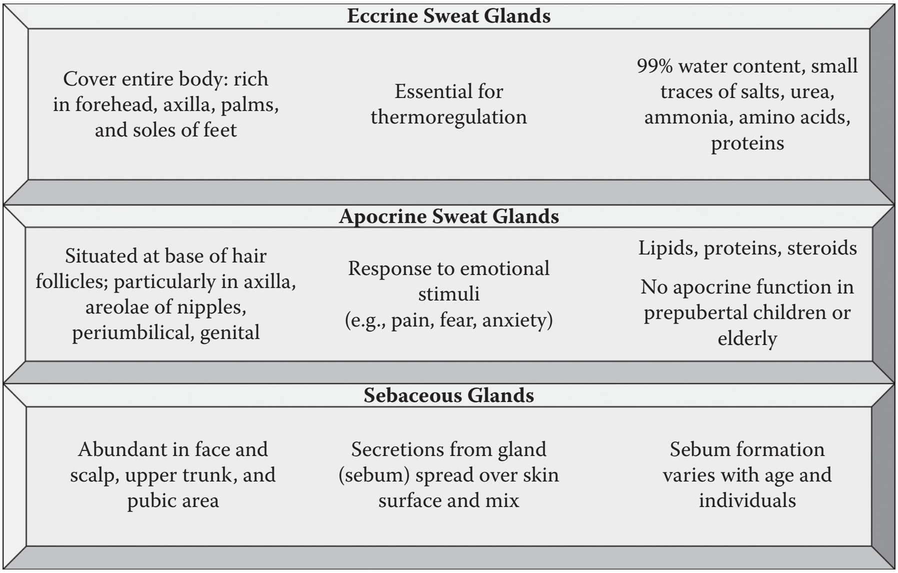
The dermis is the second layer of the human skin. It can be described as a composite tissue that obtains its strength from collagen fibers. These fibers are in a gel-like matrix of salts, water, and proteins. The most important cells of the dermis layer are the fibroblasts, which are collagen rich and allow for the tensile strength of the skin. There is also a complex structure of connective tissue fibers located in the dermis, a network of blood vessels, sweat glands, oil producing glands, and hair follicles. The dermis is also responsible for processes such as nutrition, heat exchange, repair, and thermal regulation.[25]

The hypodermis is just below the dermis. This layer consists of a network of fat cells known as adipocytes. Its main function is to connect the skin to underlying bone and muscle. This area is important for energy storage and metabolism. Furthermore, the hypodermis provides insulation and protection against injury. The intracellular fat droplets act as a depot for many compounds which are able to permeate through the stratum corneum. Since the hypodermis has a circulatory network, compounds that are able to enter into this layer can also be said to be able to distribute throughout the body.[24]

2.1.2.2 Skin Glands

Human skin plays a key role in the thermal regulation of the body and hence is equipped with appendages that aid in this function. These are represented by human secretion glands that include the eccrine, apocrine, and sebaceous glands (Figure 2.3). A brief description of each of these appendages will be discussed as these glandular secretions contribute to the generation and constitution of an individual's odor signature. Fresh secretion (of both sebum and sweat) is odorless, but combined with the metabolic activity of skin bacteria transforms these secretions into an odorous component of body odor.

2.1.2.2.1 Eccrine Sweat Glands A human has approximately 3–4 million eccrine glands in the skin. Each of these glands excretes a watery perspiration to aid in the cooling of the body to a core temperature of 37.5°C. Considering a maximum effort, the eccrine glands are capable of excreting up to 3 liters per hour. A large concentration of eccrine glands is found in the palms of the hands and the soles of the feet. These glands are characterized by having long thin ducts which open directly onto the skin surface. Eccrine gland activity is governed by neural stimulation directed by nerve fibers located around



Eccrine Sweat Glands		
Cover entire body: rich in forehead, axilla, palms, and soles of feet	Essential for thermoregulation	99% water content, small traces of salts, urea, ammonia, amino acids, proteins
Apocrine Sweat Glands		
Situated at base of hair follicles; particularly in axilla, areolae of nipples, periumbilical, genital	Response to emotional stimuli (e.g., pain, fear, anxiety)	Lipids, proteins, steroids No apocrine function in prepubertal children or elderly
Sebaceous Glands		
Abundant in face and scalp, upper trunk, and pubic area	Secretions from gland (sebum) spread over skin surface and mix	Sebum formation varies with age and individuals

Figure 2.3 Human secretion glands.

Table 2.1 Substances Recovered from Human Sweat

Less Than 0.1 mg/l	0.1–0.99 mg/l	1.0–9.9 mg/l	10–99 mg/l	More Than 99 mg/l
Iodine	Bromide	Potassium	Chloride	Glycine
Magnesium	Fluoride	Sodium	Phosphate	Ornithine
Manganese	Calcium	Copper	Sulphate	Serine
Cadmium	Iron	Methionine	Alanine	Urea
Lead	Zinc	Taurine	Arginine	Mucoprotein
Nickel	Cystine	Glutamine	Citrulline	Lactic acid
Acetylcholine		Cysteine	Histidine	
Vitamins		Creatinine	Isoleucine	
		Uric acid	Leucine	
			Lysine	
			Phenylalanine	
			Threonine	
			Tyrosine	
			Valine	
			Asparaginic acid	
			Glutamic acid	
			Asparagine	
			Ammonia	
			Urocanic acid	
			Glucose	
			Pyruvic acid	

Source: Noble W.C., 1992, *The Skin Microflora and Microbial Skin Disease*, London: Cambridge University Press.[24]

the gland. The sweating rate is directly correlated to the skin temperature, although it can also be linked to a nervous reflex. It is known that the composition of sweat varies depending on body region. Sweat is a clear, odorless, colorless, acidic fluid containing up to 99% water. The remainder of sweat composition is attributed to electrolytes NaCl, K^+, and HCO_3^-.[27] There is no general or average chemical composition of human sweat as it varies across individuals, body locale, and samplings of the same person. Table 2.1 provides an estimate composition of sweat at the skin surface.[23]

2.1.2.2.2 Apocrine Sweat Glands Apocrine sweat glands exist at birth; however, their activity starts at the onset of puberty. Apocrine glands are restricted to hairy body areas (i.e., groin, anal region, axilla, areola of the breasts, and the beard region), as their ducts exit toward the skin surface via the hair follicles. Like the eccrine glands, they also secrete sterile, odor-free, and weakly acidic product. Apocrine glands, however, secrete a thicker and more viscous milky sweat due to their higher concentration of fatty acids and other compounds such as squalene, triglycerides, ammonia, and sugars.

They become odorous after interaction with the bacteria on the skin surface. Apocrine glands are not responsive to heat changes; however, emotional stimuli (anxiety, pain, sexual arousal) are associated with increased secretions.[26]

2.1.2.2.3 Sebaceous Glands Sebaceous glands are commonly associated with hair follicles. There are up to 800 cm^{-2} sebaceous glands on the scalp and face, while being less concentrated in other body areas. The excretion of sebum is a slow process which takes from 6 to 9 days. Sebum can be described as a complex mixture dependent on age and diet. It is a yellowish viscous fluid that contains fatty acids, triglycerides, squalene, wax esters, and free sterols. In general it can be said that normal sebum production is at a rate of 0.3 mg of sebum per 10 cm^3 per hour. It has also been speculated that human sebum acts as a carrier compound that retards the liberation of odorous molecules.[23,26]

2.1.3 Skin Microbiota

Not only is the human skin a thermoregulation organ, with numerous glands serving this function, but also the first barrier of defense against outside pathogens and infections. It has been established that skin bacteria play a vital role in the formation of body odor, as has been seen with the biotransformation of odorless gland secretions with microflora that inhabit the skin surface.[28] The variation in the types and density of microflora on the skin depend on factors such as the particular body location (Figure 2.4), pH, moisture level, and nutrient availability. Hydration, for example, has profound effects on microbial populations. Occluded sites such as the axillae and groin tend to have high densities of microorganisms, while areas with low water content (forearm) have reduced microbe densities. It has been shown through multiple skin samplings that the variation in skin microbiota is much higher between individuals than within an individual, hence providing another link to individuality.[29]

Human skin is characterized by the presence of four main types of bacterial flora, namely, *Staphylococci, Micrococci, Corynebacteria,* and *Propionibacteria*. *Propionibacteria* can be depicted as Gram-positive nonmotile rods with irregular short branching. In healthy individuals of adult age, this type of microflora can be found in relatively large numbers on the surface, especially those that are sebum-rich regions such as the head, chest, and back areas. They are a benevolent type of bacteria which has a low occurrence of disease. *Micrococci* and *Staphylococci* are also Gram-positive nonmotile, nonsporing spherical-shaped bacteria. *Corynebacteria* are the last type of skin microflora present, and can be defined as Gram-positive nonsporing bacteria. *Propionibacteria* are known to contribute in the development and preservation of skin immunity. Negative consequences of these

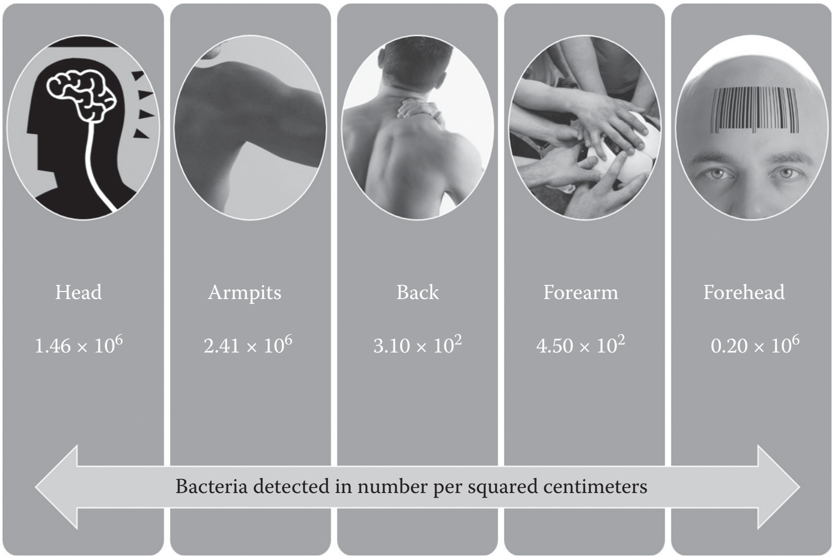
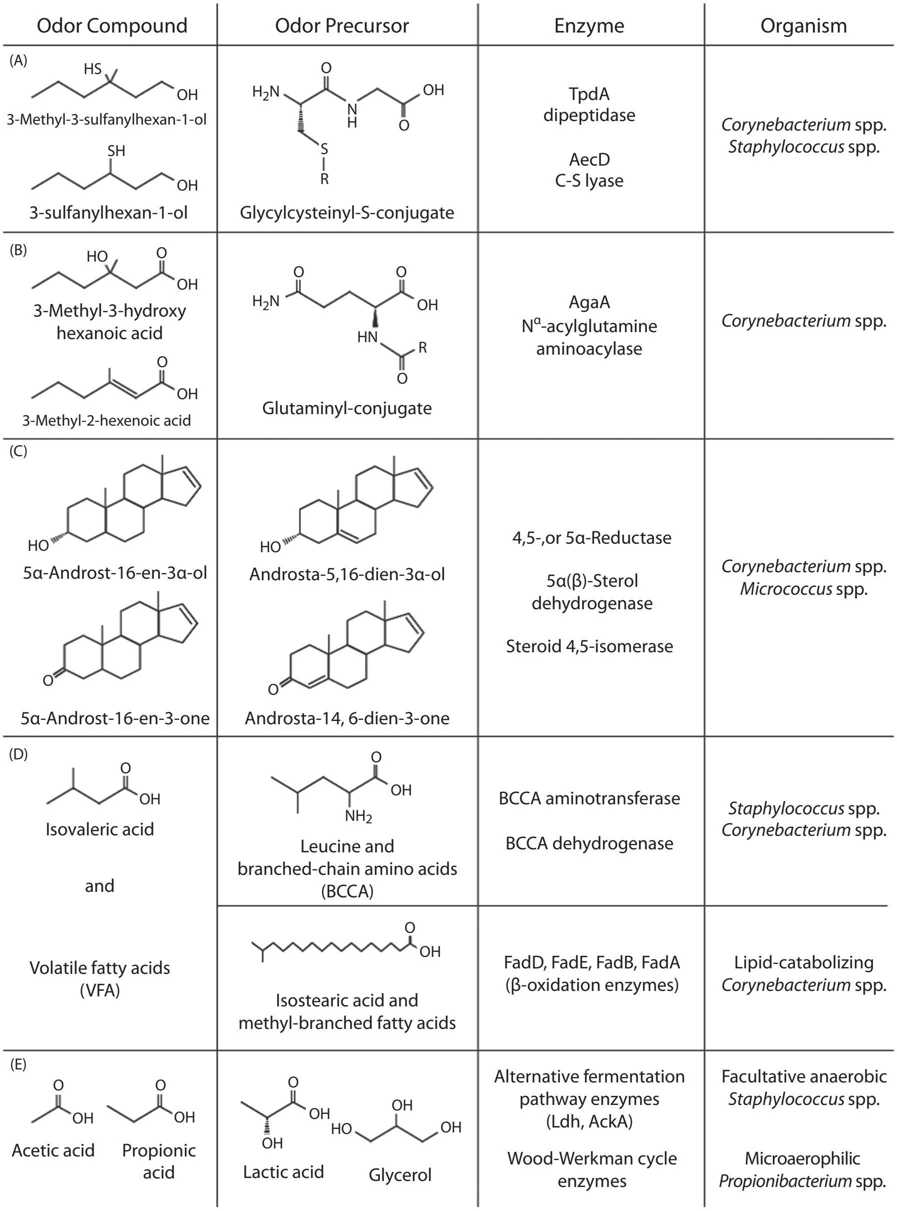


Figure 2.4 **(See Color Insert.)** Number of skin microbiota as a function of body region. (Data adapted from Yamazaki S., Hoshino K., Kusuhara M., 2010, Odor Associated with Aging, *Anti-Aging Medicine*, 7, 60–65.[30])

types of bacterial flora include minor issues such as body malodor and possible irritation in the form of acne or major health risks such as infection of implants. Areas of skin with high densities of sebaceous gland activity will have microflora of the type *Propionibacteria*, while more humid and moist areas have a greater concentration of *Staphylococci* and *Corynebacteria*. Last, the pH of the skin is an important factor in the phenotype of individual microbial species. Skin pH ranges from 5.0 to 6.3 and the growth rate of bacterial populations is influenced by any change of the pH value since they must use energy to maintain homeostasis.[31–34] Together, all of these factors not only help understand the biological pathways of odor formation, but also explain from a scientific perspective the origins of distinctive odor signatures among a population.

2.1.4 Human Axillary Odor

In an effort to elucidate the definition of human scent and understand body odor formation mechanisms, intensive research has taken place in the cosmetic industry in the area of axillary sweat. Even though this has led to the identification of a number of characteristic odorous compounds (see Figure 2.5), it is important to highlight that this does not equate into the general body "odor-print" composition, much less to the definition of what a canine alerts to when making a positive scent match. It is important,



Odor Compound	Odor Precursor	Enzyme	Organism
(A) 3-Methyl-3-sulfanylhexan-1-ol 3-sulfanylhexan-1-ol	Glycylcysteinyl-S-conjugate	TpdA dipeptidase AecD C-S lyase	*Corynebacterium* spp. *Staphylococcus* spp.
(B) 3-Methyl-3-hydroxy hexanoic acid 3-Methyl-2-hexenoic acid	Glutaminyl-conjugate	AgaA N^{α}-acylglutamine aminoacylase	*Corynebacterium* spp.
(C) 5α-Androst-16-en-3α-ol 5α-Androst-16-en-3-one	Androsta-5,16-dien-3α-ol Androsta-14, 6-dien-3-one	4,5-,or 5α-Reductase 5α(β)-Sterol dehydrogenase Steroid 4,5-isomerase	*Corynebacterium* spp. *Micrococcus* spp.
(D) Isovaleric acid and	Leucine and branched-chain amino acids (BCCA)	BCCA aminotransferase BCCA dehydrogenase	*Staphylococcus* spp. *Corynebacterium* spp.
Volatile fatty acids (VFA)	Isostearic acid and methyl-branched fatty acids	FadD, FadE, FadB, FadA (β-oxidation enzymes)	Lipid-catabolizing *Corynebacterium* spp.
(E) Acetic acid Propionic acid	Lactic acid Glycerol	Alternative fermentation pathway enzymes (Ldh, AckA) Wood-Werkman cycle enzymes	Facultative anaerobic *Staphylococcus* spp. Microaerophilic *Propionibacterium* spp.

Figure 2.5 Important odorous compounds identified in axillary sweat. (Reprinted from Fredrich E. et al., 2013, *Trends in Microbiology*, 21, 307. With permission from Elsevier.[35])

however, to acknowledge the contribution of axillary odor into the general scent picture, and discuss yet another pathway for individualistic traits of human scent.

The axillary region is a suitable habitat for odor production, as it harbors hair follicles with sebaceous glands in high densities. Since this body region is occluded, it also allows dense microflora colonization reaching up to 10^6 cells per square centimeter. The biotransformation of these secreted nutrients in the axillary region yield to routes of individualized odor profiles.[35] It has been shown that short-chain (C_2-C_5) volatile fatty acids are one of the major groups of molecules contributing to malodor. Studies have shown that skin microflora such as *Staphylococci* are capable of converting branched amino acids such as leucine into odorous short-chained (C_4-C_5) methyl-branched volatile fatty acids such as isovaleric acid. Further *in vitro* analysis showed that yet another group of bacterial populations such as *Corynebacterium* are also capable of fatty acid biotransformation that results in axillary malodor.[36] Research conducted by Zeng et al. established that axillary extracts exhibited a number of volatile C6 to C11 straight-chain, branched, and unsaturated acids as major contributors to underarm malodor with a major contribution originating from (E)-3-methyl-2-hexenoic acid.[37] It appears that this acid is covalently linked to a glutamine residue in fresh axilla secretions.[38] It has been shown that this primary odor molecule is secreted into the apocrine gland bound to two carrier proteins known as apocrine secretion odor-binding proteins (ASOB1 and ASOB2). It has been hypothesized that since these proteins carry apocrine secretions, individuals secreting substantial amounts of ASOB2 are likely to produce higher levels of underarm malodor.[39] Studies have also entailed an understanding of what constitutes odorous intensities in different individuals. Some findings have shown that the known greater intensity of axillary odor in males, for example, is not due to qualitative differences in odorants or to any differences in carrier proteins, but rather in the availability of nonodorous precursor materials in apocrine secretion, which male subjects may secrete more easily.[40] Other research groups have identified acids such as 3-hydroxy-3-methylhexanoic acid as key odoriferous acidic compounds in the axillary region.[41] These volatile carboxylic acids are released from glutamine conjugates secreted in axillary skin by a specific N-acyl-glutamine-aminoacylase present in skin microflora.[22] Besides the known odoriferous acids typically found in axillary extracts, there has also been reports of sulfanylalkanol type of compounds such as 3-sulfanylhexan-1-ol, 2-methyl-3-sulfanylbutan-1-ol, 3-sulfanyl-pentan-1-ol, and 3-methyl-3-sulfanylhexan-1-ol. These compounds are characterized by a pungent sweat/kitchen odor in the pg/l range. The odorless precursors for these compounds are thought to be cysteine conjugates.[42–44] Other types of compounds readily found in sweat are steroids. Among the most important is 5a-androst-16-en-3-one, which is supposed to be characteristic of male

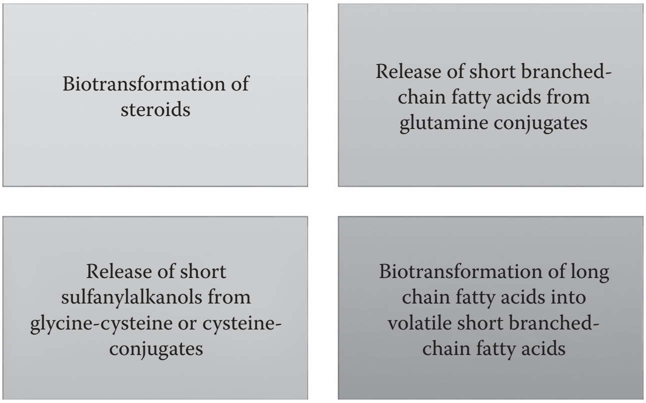

Biotransformation of steroids
Release of short branched-chain fatty acids from glutamine conjugates
Release of short sulfanylalkanols from glycine-cysteine or cysteine-conjugates
Biotransformation of long chain fatty acids into volatile short branched-chain fatty acids

Figure 2.6 Major mechanisms of odor formation.

odor. This steroid is the result of metabolic processes of coryneform bacteria that is reactive in male axilla, thus higher concentrations are found in men than in women.[45] In turn, the analysis of volatiles from axillary sweat has corroborated a genetic origin, as volatile patterns detected are significantly more similar to genetically related individuals than that of unrelated people. There have also been reports of reproducible differences between smokers/nonsmokers, genders, and age clusters <30 years/>30 years.[46] The evaluation of these gas chromatograms for sweat composition volatiles gives scientific potential to utilize sweat compounds as contributors of personal odor signatures.[47] Other groups have further supported the idea that among the detected compounds in axillary sweat there are individually distinct and reproducible GC-MS fingerprints, a reproducible difference between genders and the identification of over 44 individual and 12 gender-specific volatile chemical structures.[48]

Progress is currently underway to understand the routes of odor formation. However, to summarize this technical evaluation of axillary odor, the most generally accepted mechanisms are shown in Figure 2.6.

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Chemical Composition of Human Scent
A Volatile Perspective
3

3.1 The Chemistry of Human Scent-Skin Emanations

> He had preserved the best part of her and made it his own: The principle of her scent.[1]
>
> **—Patrick Süskind**

In Chapter 2, various odor-producing sources from a physiological and genetic perspective were explored. In doing so, the door was opened to the understanding of scientific sources of how each person's body odor is generated and hence how these physiologic processes contribute to an individuality feature. However, it is difficult to define what a dog is really alerting to when it makes a scent match. It is impossible to say with certainty what process, molecule, protein, or mixture is truly allowing for scent discrimination by a dog's nose. To further expand on the definition of human scent, this chapter will explore odor from an outside perspective, that of human skin volatiles.

3.1.1 The Quest for Nonaxillary Skin Volatiles

Human scent deposited at crime scenes is most readily collected from handled objects, or from direct contact between victim/assailant. The focus of the studies mentioned will be to that of the hands/forearms since it provides the most useful information to the forensic community.

The odorous volatiles emitted by the human skin have been of great interest not only from a forensic perspective, but also as diagnostic tools for disease biomarkers[2] as well as for insect–host interactions in chemical ecology.[3,4] In Chapter 2, the volatiles emanating from the body can be described as a combination of various processes that may include: glandular secretions from the eccrine, apocrine, and sebaceous glandular action within the skin, external factors applied to the skin (environmental contamination, creams applied to the skin surface, as well as cosmetics and toiletries), passage of compounds from the blood vessels, diet, lifestyle, and products and byproducts of skin microflora.[5] It is known, however, that possible incomplete oxidation of acquired nutrients by skin microflora could result in other small volatile breakdown and elimination compounds.[6,7] It has also been shown that much of the volatile organic compounds (VOCs) produced by the skin are released to the environment with emission patterns that are characteristic of climate conditions.[8]

The need for robust skin sampling methods have led worldwide research groups to exploit different analytical instrumentation for enhanced results. The chemical odor profiles detected from skin have been numerous in the literature, variations depending on body region and sampling method. A recent review by Dormont and colleagues[9] confirms the isolation and identification of over 400 compounds from skin extracts. However, the compounds that give the body its detectable odor are anticipated to be in the volatile to semivolatile range, hence the ample number of studies exploiting headspace collection techniques to “catch” these airborne volatiles. All of these studies have identified compounds of varying functionality including acids, esters, aldehydes, alkanes, short chain alcohols, and ketones. Figure 3.1 summarizes some of the most frequently occurring compounds from a range of 31 studies reviewed. Frequently occurring compounds have included aldehydes such as nonanal and decanal, and ketones including 6-methyl-5-hepten-2-one and (E)-6,10-dimethyl-5,9-undecadien-2-one. The most common headspace technique exploited has been solid-phase microextraction (SPME), which has proven to be of great potential not only for human odor but for a wide range of forensic applications in the last few decades.[10] In a recent study conducted by Gallagher et al., approximately 100 compounds were identified via this approach highlighting VOC profiles of the upper back and forearm within the same individual to be highly similar with noteworthy differences.

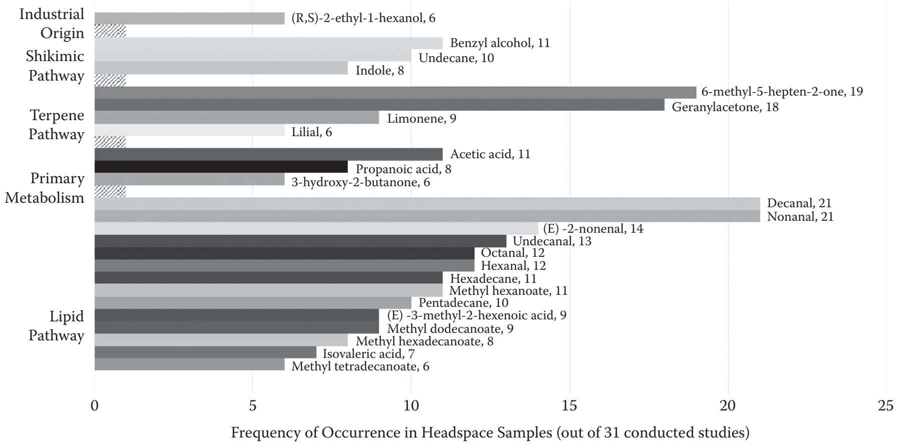

Figure 3.1 **(See Color Insert.)** The 25 most frequently isolated compounds in headspace odor samples. (Data adapted from Dormont L. et al., 2013, Human Skin Volatiles: A Review, *Journal of Chemical Ecology*, 39, 569–578.[9])

Aldehydes of C8-C12 were detected in most samples for almost every subject and the presence of ketones such as 6-methyl-5-hepten-2-one and geranylacetone was also consistent among the sampling pool.[11] Zhang et al. has also utilized solid-phase microextraction coupled with gas chromatography-mass spectrometry (SPME-GC/MS) as the analytical tool of choice providing results that suggest that skin emanations are composed of alkenes, alkanes, alcohols, aldehydes, and esters characteristic of the individual sampled. This study concluded that there is a clear effect on environmental changes such as climate that affects the emission behavior of human odors.[12]

Skin volatile organic compounds have also been investigated by techniques such as secondary electrospray ionization-mass spectrometry from the hands of two individuals highlighting the presence of a family of amines including: trimethylamine, ethanolamine, 1-amino-2-propanol, piperidine, isobutylamine, hexylamine, heptylamine, and octylamine. Ornithine was also reported, which had previously been reported to be a constituent of sweat.[13] Other groups have used glass beads to collect and transfer skin constituents from the palms of the hands to GC/MS for investigations of mosquito attractiveness.[14] Soini's research group implemented stir-bar sorptive extraction techniques to sample inner arm skin surfaces as well as fresh fingerprints on a mirrored surface. The results highlighted approximately 100 compounds tentatively identified, with squalene being a common peak in all samples collected. A substantial individual-to-individual variation was observed, while replicated intra-individual samples remained stable, hence providing a potential in forensic discrimination studies.[15] Other methods of analysis commonly employed for the collection of volatiles include dynamic headspace adsorption directly onto various types of polymers (i.e., Tenax). Whole body studies have been conducted using either heat-sealed oven or aluminized plastic bags along with adsorbent columns of Tenax GR and Porapak Super Q as the method of collection. These studies have highlighted compounds such as C7-C10 aldehydes as major constituents of body odor extracts.[16,17]

3.1.2 At the Forefront of a Lab-Based Scent Discrimination Method

As shown, the number of studies conducted for human scent volatile elucidation are numerous. However, the studies directed for volatile identification strictly for forensic purposes and canine research are nonexisting. The research group at the International Forensic Research Institute (IFRI) has pioneered this field of study since the early 2000s. The Furton research group has performed chemical analysis studying a range of human scent questions, including the identification of compounds responsible for a chemical "odor print" from various biological specimens, their variation across a population, their stability within a person, differences in odor profiles with a range of textiles and collection methods, storage conditions, and ultimately the development of a potential biometric measure. The researchers have worked closely with experts in the canine field to couple laboratory findings to answer key operational questions of human scent canine applications. This section will focus on the development of the instrumental technique for human scent analysis and the potential as a profiling tool. Studies on collection methods, materials, and storage will be explored in Chapters 5 and 6.

Preliminary studies in the IFRI laboratory focused on analyzing axillary sweat samples to develop a feasible solid-phase microextraction gas chromatography-mass spectrometry method. A diagram of the SPME-GC/MS assembly can be seen in Figure 3.2.

The developed SPME-GC/MS method allowed for the successful identification of volatile organic compounds (VOCs) above sweat samples. Qualitative differences and similarities were observed between both genders, along with significant differences in chemical ratio patterns that allowed the differentiation of individuals through the use of these VOCs (Figure 3.3). It has been defined in these studies that individual body odors can be classified into the following categories: primary odor resulting from the constituents that are stable over time regardless of diet or environmental factors, secondary odor containing constituents that are present due to diet and

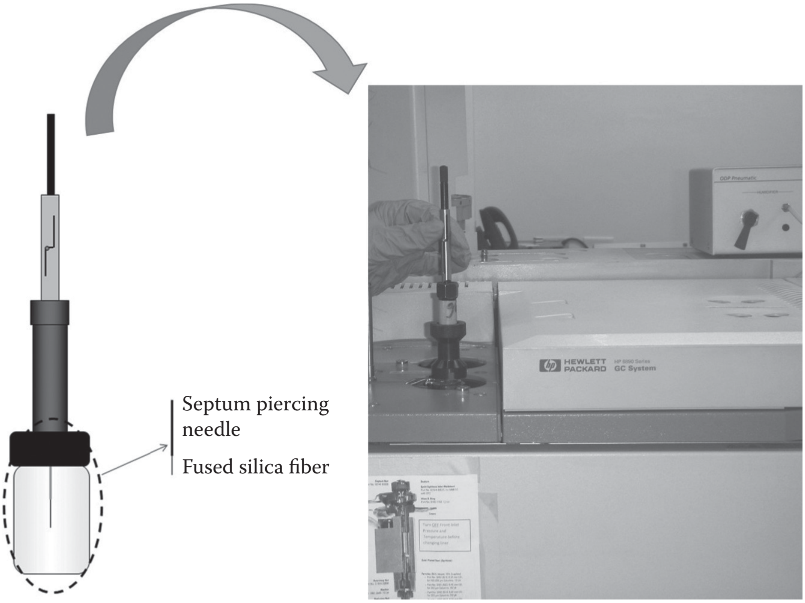

Figure 3.2 Solid-phase microextraction gas chromatography-mass spectrometry (SPME-GC/MS).

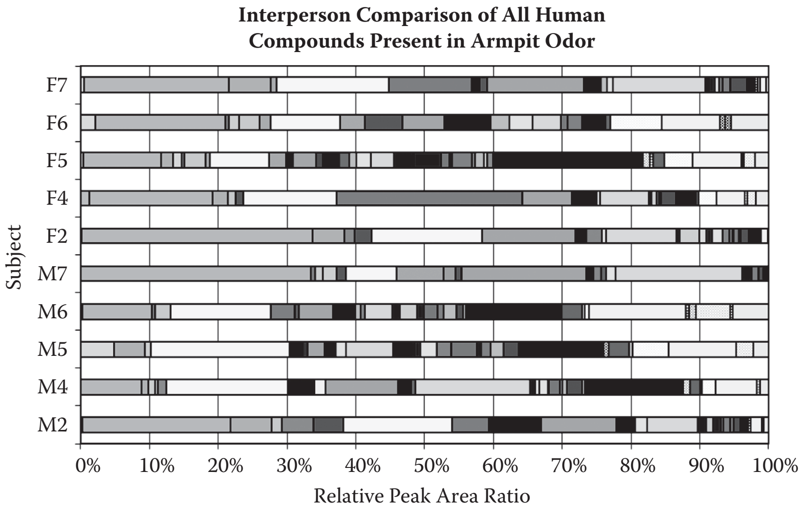

Figure 3.3 **(See Color Insert.)** Chemical odor profiles from axillary sweat samples. (Data from Curran A.M., 2005, The Analytical Determination of the Uniqueness and Persistence of the Volatile Components of Human Scent Using Optimized Collection Methods, Doctoral dissertation, Florida International University.[20])

environment, and tertiary odor that are present due to outside sources such as lotions, soaps, or perfumes.[18,19]

To further validate the feasibility of these results into a more practical forensic application, the SPME method was applied to the analysis of hand odor volatiles. Of the 60 volunteers in the study, a total of 63 compounds were identified as high, medium, and low frequency occurring compounds among the population (Figure 3.4).[21] Some of these compounds were detected across the population with a high frequency, such as phenol, nonanal, and decanal, which were present in 100% of the subjects. 6,10-dimethyl-5,9-Undecadien-2-one and hexanedioic acid-dimethyl ester are observed in approximately 80%, while other compounds including heptanal and octanal are seen in less than 30% of the population. Through the use of the statistical technique of Spearman rank correlations, the dataset was successfully evaluated, yielding an innovative approach for hand odor distinguishability.

The comparison of the 60 subjects generated 1770 possible pairs for comparison. Considering a 0.9 as a match/no-match threshold allowed us to distinguish the individuals in 99.66% of the cases.

In the pursuit of a more refined instrumental technique that could be applied in a forensic context, the importance of obtaining a human scent "odor baseline" prior to comparison of odor profiles among a population was proven. In this seminal work,[22] the hand odor samples of 10 individuals were

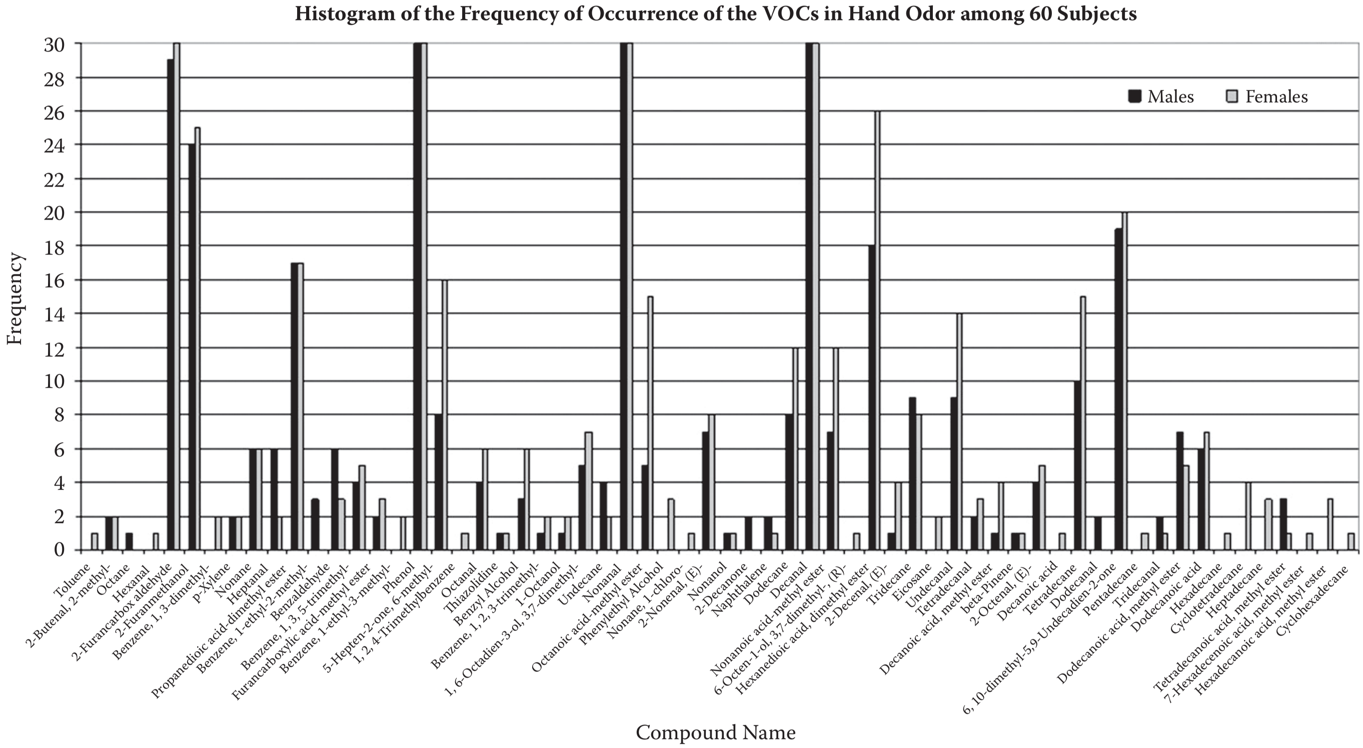

Figure 3.4 Histogram of the frequency of occurrence of human compounds above hand odor samples. (Reprinted from Curran, A.M. et al., 2007, *Journal of Chromatography B*, 846, 91.[21] With permission from Elsevier.)

evaluated. The Spearman rank correlation discussed yielded a distinguishability of 88.05% at the 0.9 match/no match threshold using 37 previously reported compounds. However, when restricting these compounds to what has been coined as an individual's primary odor (only those compounds present in all intraday samples), the compounds used for analysis were reduced to a set of 24 compounds (Figure 3.5). When performing the Spearman correlations again with this new set of database compounds, the distinguishability increased to 99.54% at the same threshold mark. To extend the application of this "human scent barcode" technique, and to prove the hypothesis of the potential development of a human scent database, the same samples from the 10 subject pool were added to the Spearman rank profiles into a library of 52 subjects, only using the standard set of 24 primary odor compounds. The distinguishability was obtained in 99.34% of the cases, thereby allowing for a proof of concept into the usefulness of primary odor compounds as a marker of individual differentiation via a statistical approach. This laboratory finding very well solidified the anecdotal evidence for a unique odor signature among individuals, hence helping canine research.

Efforts in the laboratory have not only exploited hand odor volatiles as markers of individuality, but also other biological specimens of interest such as blood, urine, breath, and buccal swabs.[23,24] These studies have shown for the first time the ability to differentiate individuals based on human scent compounds from a range of distinctive biological matrices. It highlighted the notion that the chemical odor profile of different biological specimens from the same individual were different for matching purposes. However, a time study (over a 6-month period) showed that the VOC profiles of one individual do not vary as much as interindividual samples. These results further support (via a laboratory procedure), the individual odor theory of human scent.

More recently, the use of novel biological specimens such as hair and fingernails as potential sources of odor for differentiation purposes in a forensic evaluation have even been explored.[25] The analysis of the VOCs being released by hair and fingernails showed that their odor profile possessed sufficient intrasubject similarity to produce a high correlation coefficient (>0.9) between samples. The high percentages of differentiation obtained when comparing each specimen across all other specimens (including buccal swabs and hand odor) collected signifies that each specimen provides an elevated level of discrimination with a volatile profile distinct enough for each individual. Hence, although each biological matrix has a distinctive odor being released, the level of uniqueness is high enough for instrumental detection.

Now that the sources and pathways of human odor production as well as a review of laboratory findings on the volatile definition of human scent have been covered, evaluation of the factors that affect human scent variability in real life, where actual case work takes place, is needed.

	R.T.	Compound Name	Subject, Sample																													
			F1, 1	F1, 2	F1, 3	F2, 1	F2, 2	F2, 3	F3, 1	F3, 2	F3, 3	F4, 1	F4, 2	F4, 3	F5, 1	F5, 2	F5, 3	M1, 1	M1, 2	M1, 3	M2, 1	M2, 2	M2, 3	M3, 1	M3, 2	M3, 3	M4, 1	M4, 2	M4, 3	M5, 1	M5, 2	M5, 3
▨	3.86	Pyridine													x	x	x															
▨	4.68	2-Butenal, 2-methyl-													x	x	x															
▨	5.70	Butanoic acid	x	x	x										x	x	x															
▨	6.50	2-Furancarboxaldehyde	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
▨	7.20	2-Furanmethanol													x	x	x							x	x	x	x	x	x			
▨	8.32	Nonane													x	x	x															
▨	9.03	Propanedioic acid, dimethyl ester																x	x	x										x	x	x
▨	9.72	Benzaldehyde	x	x	x										x	x	x							x	x	x						
▨	10.24	Phenol	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
▨	11.26	Benzyl Alcohol				x	x	x																x	x	x						
▨	12.37	1,6-Octadien-3-ol, 3,7-dimethyl-																						x	x	x						
▨	12.38	Undecane																												x	x	x
▨	12.47	Nonanal	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
▨	12.82	Octanoic acid, methyl ester																x	x	x	x	x	x									
▨	13.42	2-Nonenal, (E)-																														
▨	13.89	2-Decanone	x	x	x										x	x	x				x	x	x									
▨	14.02	Dodecane	x	x	x							x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
▨	14.12	Decanal	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
▨	14.42	Nonanoic acid, methyl ester																x	x	x	x	x	x							x	x	x
▨	14.76	Hexanedioic acid, dimethyl ester				x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x				x	x	x
▨	15.49	Tridecane	x	x	x										x	x	x							x	x	x						
▨	15.62	Tetradecane	x	x	x										x	x	x	x	x	x				x	x	x						
▨	17.82	5, 9-undecadien-2-one, 6, 10-dimethyl	x	x	x	x	x	x							x	x	x	x	x	x	x	x	x	x	x	x						
▨	18.87	Dodecanoic acid													x	x	x															

Figure 3.5 **(See Color Insert.)** Set of 24 primary odor compounds used for sample discrimination. (Reprinted from Curran, A.M. et al., 2010, *Journal of Forensic Sciences*, 55, 53.[22] With permission from Elsevier.)

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Variability of Human Scent

4

4.1 Human Scent in the Natural Environment

> And although our bodies are bounded with skin, and we can differentiate between outside and inside, they cannot exist except in a certain kind of natural environment.*
>
> **—Alan Watts**

The information covered thus far has entailed the scientific approach to the definition of human scent. Review of basic physiological processes of human odor production, as well as various analytical techniques have helped scientists understand the human odor signature. By doing so, not only is it hoped to provide some basic fundamentals of the biological origin of human scent, but also the distinctive characteristics of odor generation that make it an individualizing physical trait. It is acknowledged that scent evidence is not entirely governed by intricate scientific theories and principles, and that the value of scent evidence lies in the behavior of a handler's loyal companion—the canine nose. In practical case work, the definition of human scent stems away from sweat glands and skin composition and lies more in the ability of the dog to make a scent match or follow a particular scent trail in a given situation. In order for this to happen, however, there are many factors in our surroundings that affect how human scent is transferred and ultimately deposited in the environment in order for the dog to efficiently use it. Human scent is not stable and this variability is the direct effect of external environmental conditions that a canine handler must consider in order to make the most out of the canine search. Theories of human scent transmission will be explored as well as atmospheric parameters crucial to the success of canine teams working with locating and following human scent.

4.1.1 Scent Transfer

Up until now, human scent has been presented as a result of glandular secretions, genetics, and volatile organic compounds giving off a particular "odor

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* Watts, A. (1989) *The Book: On the Taboo Against Knowing Who You Are*. New York: Random House.

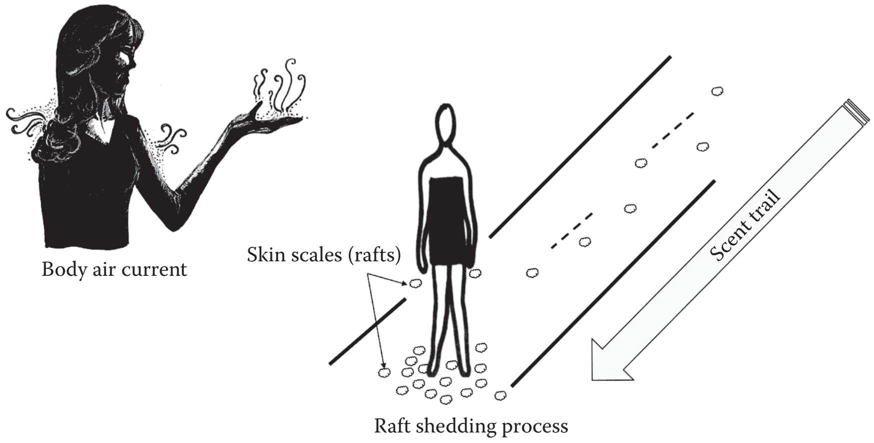


Figure 4.1 Human scent transfer mechanisms. (Illustration courtesy of Megan Friesen.)

signature" for every individual. The next step, however, is understanding how this odor signature reaches the environment for canine use in practical scent work scenarios. The two main pathways are a raft shedding process and an air body current that assists in the removal of these rafts, indirectly, by body temperature. As can be seen in Figure 4.1, these two major mechanisms of transmission and the basics of human scent transfer will be discussed.

It is known that the epidermis (outer) layer of the skin constantly sheds epithelial cells into the environment. At the skin surface there are about 2 billion cells, of which approximately 667 are shed per second. The average life span of an epithelial cell is approximately 36 hours. These dead skin cells are commonly referred to as "rafts," which are approximately 14 microns in size and weigh approximately 0.07 micrograms. The "raft" is composed of one or more dead cells, containing skin microflora and body secretions, which all contribute to the individual's odor. Thus, these shedded rafts travel and adhere to various surfaces or can be blown away to surrounding areas before final settling.[1] The body assists in the removal of these rafts, indirectly, by having its body temperature at around 37°C. As the air around the skin usually consists of lower temperature, bodies are continually heating the air around it. As heat rises, a thermal wind is produced causing the rafts to be lifted off other layers of skin, which are then caught by atmospheric wind. Heavier rafts fall close to the subject while lighter ones drift away. Rafts, which are essentially epithelial cells, are also expelled from the lungs and lining of the respiratory tract. Skin rafts can then become colonized with bacteria, as long as suitable conditions exist.

Extensive studies by Dr. Gary Settles at Penn State University have shed light on the human thermal plume. Human body temperature is typically 9°C warmer than the surrounding air at standard room temperature

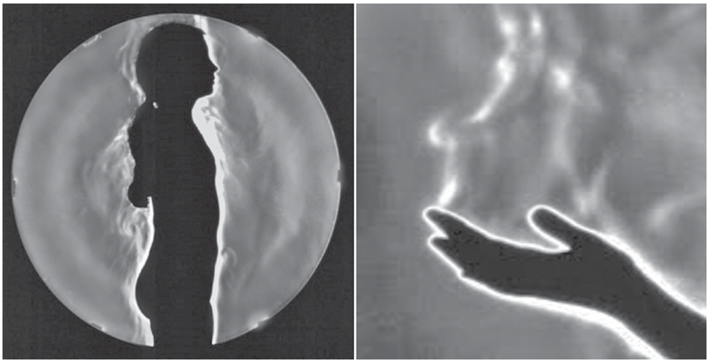

(a) (b)

Figure 4.2 (See Color Insert.) Schlieren images of the thermal plume of (a) an 11-year-old girl, (b) palm up. (Photos courtesy of Professor Gary Settles, Distinguished Professor of Mechanical Engineering, Penn State University, University Park, State College, Pennsylvania.)

conditions. These conditions cause a constant thermal convection process that transfers our body heat to the surroundings. For a resting person, this convection equates to a waste body heat transfer of around 80–100 W. The air heated by the skin rises following Archimedes' principle, thus creating a free-convection boundary layer about the body and a thermal plume above it, as can be observed from the schlieren images shown in Figure 4.2.

As can be seen in Figure 4.2, the convective boundary layer begins at the bottom (ankle region) and travels in an upward motion, with increased thickness and speed. This thickness reaches around 15–20 cm around the head, with a maximum speed of ¼ m/sec. This human thermal plume continues to rise, reaching flow rates ranging between 50 and 80 liters/sec. This human body thermal plume process is similar regardless of height, weight, or layering (clothing).[2,3] From these pivotal studies about the body's surrounding air currents, it can be confirmed that normal contact with a human body is never stationary and that our interaction with surrounding air is a continuous pattern of upward motion, containing and dispersing our unique chemical signature and tons of skin rafts into the environment. The usefulness of this transmission of human scent to our surroundings allows for the establishment of a person's direct or indirect association to a particular criminal investigation using scent as the silent evidence.

4.1.2 Factors Influencing Human Scent

The raft shedding process along with constant air currents surrounding bodies allow for scent to be transmitted into the environment. The intensity and ultimate usefulness of this deposited scent is not only based from a "body perspective," but also from the environmental conditions that are present in the particular setting of an investigation. As all canine handlers and law enforcement personnel are aware, no two cases are exactly the same. The variables involved in each deployment scenario are unique to the situation and the location of the search. However, even though an exact replication of the parameters cannot be achieved, there are some key factors that must be understood when using human scent as trace evidence. The age of scent is perhaps the most valuable parameter, but due to its importance will be discussed in Chapter 6, where the persistence of human scent will be examined in greater detail.

4.1.2.1 Temperature

One major factor to consider when conducting a canine scent exercise is temperature. Bacterial action is important in the enhancement of scent at elevated temperatures; however, both extreme hot or cold climates decrease or stop bacterial growth thus decreasing quality of scent in the environment. As the rafts age and dry, the potency of scent also decreases. In some instances, the deposited scent can be "refreshed" over time as can be seen from the hydration provided by cool temperatures where moisture is added back into the cells.[4] Hence, the time of day is also strongly correlated with this temperature and humidity effect. In the early evening, dew is present in vegetation or foliage areas. This added moisture in the environment rehydrates bacterial activity, hence offering a higher odor intensity. On the contrary, during daytime hours, the effect of sunlight quickly increases ambient temperatures and makes the scent harder to detect as this has a "drying effect" on the deposited rafts available in the surroundings. On the other side of the balance is the effect of extremely frigid temperatures. Under these conditions, scent is sort of "locked" until it thaws out. Canines working under these circumstances tend to work much closer to ground disturbance odor, as scent particles found in nearby air currents tend to freeze much more rapidly.[5] These anecdotal field observations have been corroborated, by analyzing collected hand odor samples in the laboratory at different temperatures. The studies performed used hand odor collected via the STU-100 (scent collection techniques discussed in greater detail in Chapter 5) and tested at three temperatures: 22.8, 37, and 50 degrees Celsius. In headspace extraction methods, heating the sample increases the vapor phase concentrations of the compounds found within the matrix, in this case the hand odor samples. An increase in the temperature during the extraction enhances the diffusion of analytes toward the fiber. Thus, in headspace solid-phase microextraction (SPME), the temperature helps in the transfer of analytes to the headspace. By increasing the vapor pressure of the analytes, it was hypothesized that enough energy is supplied to the sample for the compounds to dissociate from the collection medium. In turn, a similar process might be compared to the canine's nose, where an

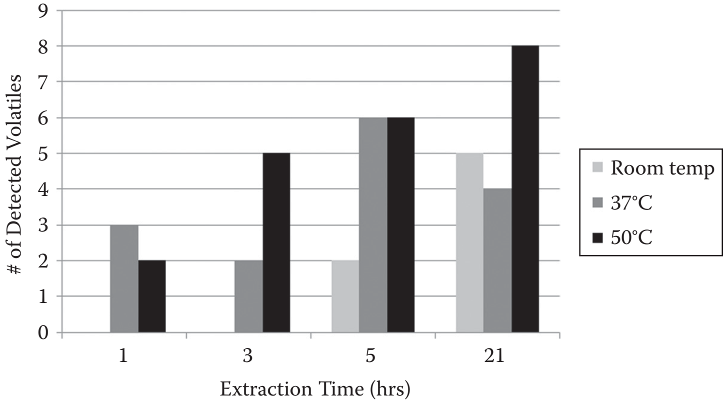


Figure 4.3 Number of detected human scent VOCs as a function of temperature. (Data from Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[6])

increase in the surrounding temperature allows for an enhanced transfer of vapors into its nasal cavity. The International Forensic Research Institute (IFRI) laboratory studies showed that with an increase of temperature the previously nonexistent chemical odor profiles at room temperature showed enhanced detection as the temperature was increased. Figure 4.3 summarizes the amount of volatiles that were collected at each extraction time and temperature, where it can be readily seen how heat improves the amount of volatile organic compounds (VOCs) detected as well as the advantage of utilizing longer extraction times. This higher number of detected compounds is necessary for the instrumental evaluation of noncontact samples and the potential for differentiation. In turn, this result indirectly confirms the effect of external temperature on the canine behavior during a scent search.

4.1.2.2 Moisture

Moisture and humidity intensify the strength and the durability of scent making the canine locate the source much more easily. Furthermore, water is able to refresh a deposited scent as long as it is not in great quantities such as a heavy downpour. On the other hand, the lack of moisture can enhance the dryness of the rafts, thereby reducing the quality of the scent. This dryness causes a fast dehydration of the skin rafts, which slows the bacterial action making it more challenging for scent to survive.[7] A canine working a dry climate may, therefore, have difficulty working in humid areas since the scent will be more intense and could be strong at first. This is why it is always suggested to let the canine acclimate to the location prior to work to compensate for these environmental changes.

4.1.2.3 Wind

Wind (air movement) plays a key role in the transport and direction of skin rafts in the environment. Canine handlers utilize tools such as flagging tape or powder to aid in the visualization of wind currents. It is crucial to move the canine into the wind to allow them to relocate the rafts. The wind speed and velocity dictates how far an individual's rafts blow and how quickly they are dispersed. The surrounding environment also plays a key role when combined with the wind factor. The surfaces, vegetation, or barriers in the location of the search affects just how far, or even how deep, skin rafts/vapors travel. Strong winds can pick up the scent and move it quite a distance. Open areas such as fields and forests can deposit scent in a multitude of places as nature plays a role in the survivability of bacteria as opposed to an urban parking lot, which has no crevices of vegetation for possible interaction. The ultimate transport of odor volatiles is then a direct function of the wind speeds as well as the direction. It can be said that these rafts as well as odorous vapors (volatiles) once evaporated from the body's boundary layer around the skin move via diffusion and bulk air movement makes it available to the dog's nose. The canine must then be able to recognize this odor and determine odor source direction, which is directly linked to the concentration. The concentration available to the dog is then a function of the target odor source in conjunction with its movement and dissipation in the air.[8]

4.1.2.4 Terrain

Terrain is yet another variable that affects the behavior of scent. The topography of the work area directly affects other variables such as wind factor. For example, low areas such as depressions or drainages are usually shaded and cooler thus making scent last longer in these locations. Rocks and cracks also provide another deposit area for scent allowing it to remain for a longer time period since they have crevices and cracks which serve as "pockets" for scent.[4] The ability of a canine to work under different terrains is also valuable, as not only are environmental parameters key but also the ability to work efficiently whether it be a grassy field, a dry-desert environment, or a busy urban neighborhood setting (Figure 4.4).

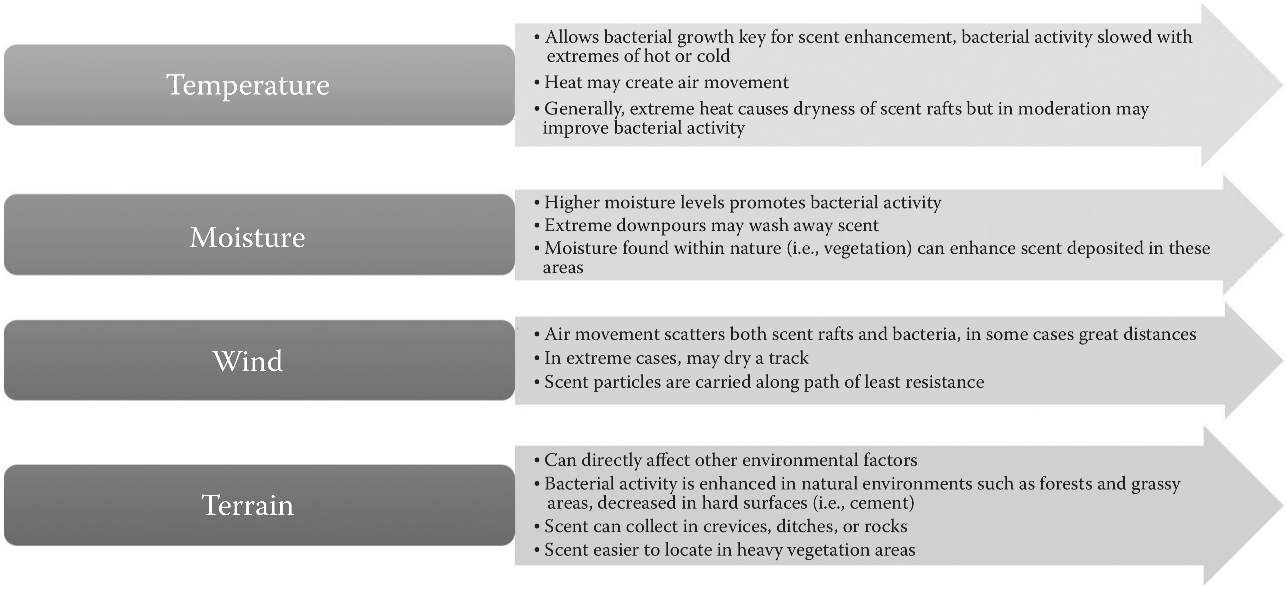
All of the mentioned parameters work in unison and together create distinctive consequences in a given working location. It is important to highlight that a canine must be trained to other external factors such as noise, children, other human subjects or animals, cars, and any other possible distractors that could confuse the dog during the search. These "external contaminant sources" may destroy, dilute, and displace a given scent trail. Having a high number of persons at a location, for example, can contaminate a scent trail by having persons other than the target walk over or across

Figure 4.4 **(See Color Insert.)** Canine scent searches under various terrain features in the United States and Argentina. (Photos courtesy of Paola A. Prada, Curtis Fish, and Dr. Mario R. Rosillo.)

the desired trail. Proper training under these circumstances can help the canine with urban work and must be a vital component of regular maintenance training. In summary, Figure 4.5 provides a concise summary of the environmental parameters discussed that could potentially affect the scent picture as the canine is performing a trailing/tracking activity.

4.1.3 Patterns of Scent Distribution

Even though environmental factors play a key role in the distribution and deposition of human scent traces, it is also important to describe some basic scent patterns. When using a scent trail, a canine uses different forms to find its source of target odor. In turn, these different forms can be directly using the ground disturbance odor picture or air scent. The most common scent distribution pattern is that of a cone formation. The scent cone is developed under ideal conditions; it spreads scent outward from the point of origin (see Figure 4.6), where the odor intensity is the strongest at the odor source and weaker as you move away from it. The shape of this cone is influenced by wind speeds and also by the roughness of the terrain. The canine starts working much faster as the scent cone narrows, thus indicating proximity to source. The second type of distribution is that of trapped scent. This is normally seen



Temperature

- Allows bacterial growth key for scent enhancement, bacterial activity slowed with extremes of hot or cold
- Heat may create air movement
- Generally, extreme heat causes dryness of scent rafts but in moderation may improve bacterial activity

Moisture

- Higher moisture levels promotes bacterial activity
- Extreme downpours may wash away scent
- Moisture found within nature (i.e., vegetation) can enhance scent deposited in these areas

Wind

- Air movement scatters both scent rafts and bacteria, in some cases great distances
- In extreme cases, may dry a track
- Scent particles are carried along path of least resistance

Terrain

- Can directly affect other environmental factors
- Bacterial activity is enhanced in natural environments such as forests and grassy areas, decreased in hard surfaces (i.e., cement)
- Scent can collect in crevices, ditches, or rocks
- Scent easier to locate in heavy vegetation areas

Figure 4.5 Environmental factors in scent dynamics.

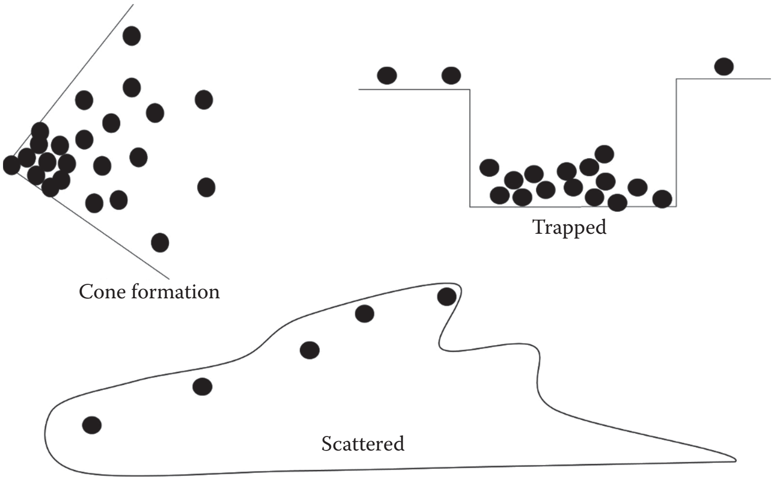


Figure 4.6 Common scent distribution patterns.

in search areas that have low areas or uneven terrains such as mountains, hills, or slopes. These types of conditions make the search more challenging as factors, such as wind, force the scent into these trapped “pocket” locations, making the canine linger on these areas even though the source is not in the vicinity. Last, scent can simply be scattered, as moderate-heavy winds hinder the formation of a cone and spreads the scent over a large area.[9] An example of scattered scent can be in an open field where the scent will follow the path of least resistance and end alongside the edge of a wooded area. Our canine detectors, however, are able to circumvent these technical challenges present in nature along with the aid of a good handler that is able to recognize these factors and adjust accordingly.

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Collection of Human Scent as Forensic Evidence

5

5.1 Collecting Scent

> Physical evidence cannot be intimidated. It does not forget. It sits there and waits to be detected, preserved, evaluated, and explained.*
>
> **—Herbert Leon Macdonell**

As with any other form of trace evidence, the collection, handling, and preservation of scent is key in order to use it in a formal legal setting. All personnel involved in the investigation have a duty to keep and preserve the evidence from date of collection until final resolution of the judicial process. This not only includes proper canine training and interpretation of behavior, but also an accurate chain of evidence in the actual acquisition of the scent source. In this chapter, the basic methods of scent collection, mediums, and objects used as scent articles as well as scientific studies evaluating an array of collection materials are discussed. Currently, there is no uniform human scent evidence collection method. Each country that uses scent as an investigative tool runs their programs and protocols a little differently. All variations make use of an absorbent medium to gather human scent, yet the materials used have not been previously optimized or standardized among the law enforcement community. It is hoped to provide not only a practical field perspective (i.e., police work) of scent collection parameters, but also laboratory findings that help clarify optimal working conditions for a useful scent sample.

5.1.1 Methods of Scent Collection

There are four methods that can be described when it comes to collecting scent. The conventional manner of collecting human scent for canine use is to allow the dog to smell the scent article/source directly (Figure 5.1). This

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* Lewis A. and Macdonell H.L. (1984) *The Evidence Never Lies*. New York: Dell, Chapter 6.

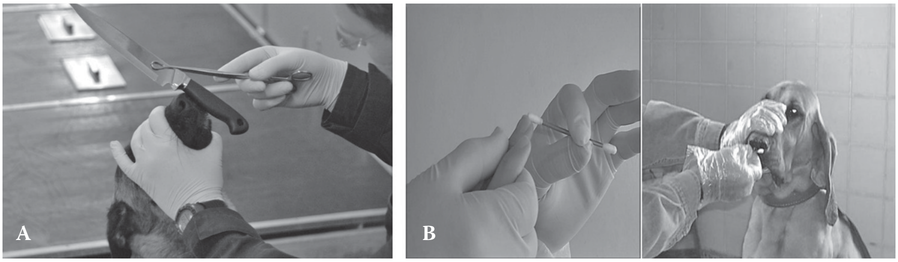

Figure 5.1 (A) Direct scenting off weapon, Finland. (Photo courtesy of Ilkka Hormila, Police Dog Training Center, Hämeenlinna, Finland.) (B) Scent wiping off fingernail area, Argentina. (Photo courtesy of Dr. Mario R. Rosillo.)

procedure, however, introduces the risk of contamination of the article by the canine and/or destruction of other forms of trace evidence such as fingerprints or DNA for further forensic analysis. It can also be challenging when the object of interest is too small. Another form commonly used is a direct wiping of the scented article or surface of interest. Generally, sterile gauze pads are used for this purpose. Gauze pads have been an excellent medium to collect scent to target the canine. However, a direct wiping approach needs to be performed taking extreme precautions not to contaminate the scent source sample. Hence, it is performed using sterile nitrile gloves, so as to prevent a cross-contamination between the person collecting and the scent being picked up. Contamination is key when obtaining the scent sample, and even though it is impossible to have a contamination-free sample, precautions when sampling do minimize this risk. Headspace absorption (or passive collection) is another common method of collecting scent. Under this method, we can describe two distinctive procedures of collection. A contact passive approach uses a sorbent material (gauze pad) in direct contact with the object of interest and both the sorbent material and object are consequently wrapped in aluminum foil for scent enhancement (see Figure 5.2). This procedure takes place between 45 min and up to 24 hours or more. This wide time range is highly dependent on the agency protocol and/or the object of interest. After the specified time allotted, the sorbent material is removed from the area/surface/object of interest using deodorized tweezers, and sealed in a glass jar. Under the headspace absorption category, we can also mention a noncontact passive approach, where the sorbent material is simply placed in close but not direct contact with the object, as in the case of an object inside a glass jar along with a gauze pad for scent transfer.

The newest method introduced specifically for human scent collection is the Scent Transfer Unit (STU-100). This device is a portable vacuum designed to draw air through 5 × 9-inch sterile gauze pads and is currently being used by law enforcement agencies as well as the Federal Bureau of Investigation. This method of collection introduces airflow to speed up the sampling

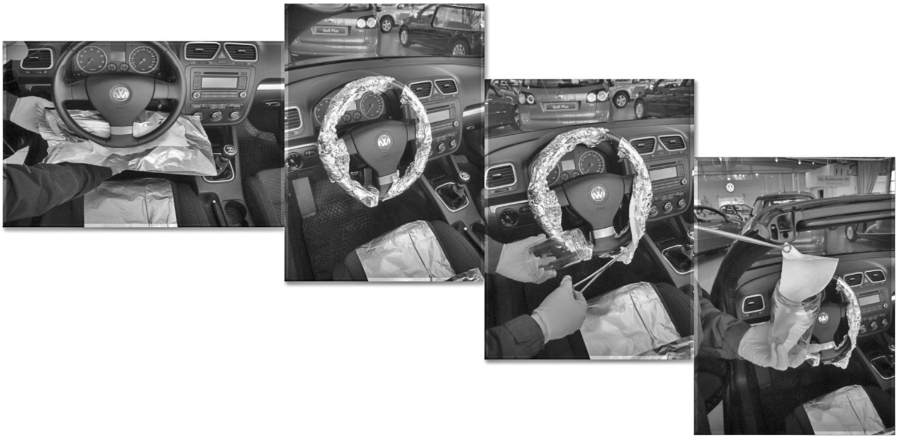

Figure 5.2 **(See Color Insert.)** Passive contact collection from a steering wheel, Finland. (Photos courtesy of Ilkka Hormila, Police Dog Training Center, Hämeenlinna, Finland.)

process. The Scent Transfer Unit allows for the ability to perform noncontact sampling and collection of human scent from objects without contaminating or altering the object of interest. Vacuum collection allows for a greater number of scent samples to be taken from the same object/individual and provides the capability of collecting scent from fixed items such as doors and steering wheels in a couple of seconds.

The Scent Transfer Unit (STU-100) was introduced by Tolhurst and Harris in 1996 as a novel human scent evidence collection device that allowed for collection of human scent without disturbance to other forms of trace evidence. Its design includes a portable case that contains a 12-volt battery as a charging system and the control for the vacuum pump airflow (Figure 5.3). The STU-100 has nine different airflow speeds ranging from 1 to 9. It has a modified inlet that is capable of holding a sterile gauze pad (12.5 cm × 23.0 cm). This gauze pad is used as the trapping medium to collect volatile components as the STU-100 pulls air through the sorbent at the running airflow rate. This scented pad then serves as the scent source to conduct an odor check with the trailing canine in the field at a later time.[1] Since 2001, the Federal Bureau of Investigation (FBI) has used the STU-100 as the exclusive means of retrieving scent off evidence. By 2005, STUs were being employed by 80 law enforcement agencies in 17 states as well as the United Kingdom. The introduction of the STU-100 has even led to judicial controversy as to the scientific validity of the device and proper standard for admissibility in courts of law. However, as observed in the California case of Benigno Salcido,[2] the STU evidence was admissible in the court, with corroboration that the person performing the technique uses correct scientific methods.

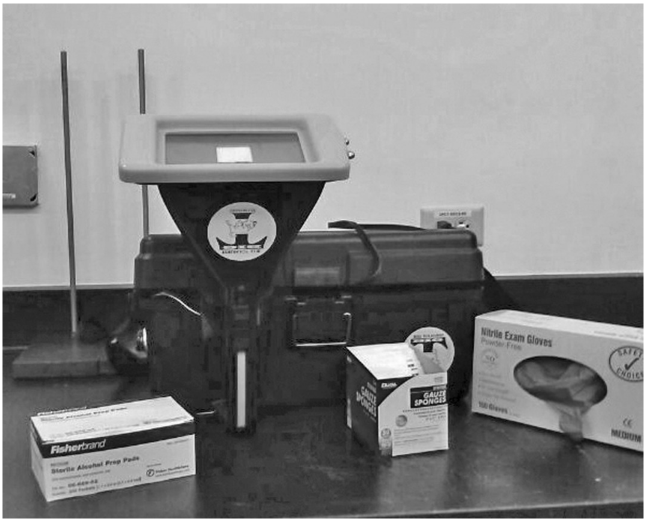

Figure 5.3 Scent Transfer Unit (STU-100) collection kit. (Photo courtesy of Claudia L. Sanchez.)

Recently, a few models have been developed to improve the scent transfer device originally invented by Bill Tolhurst Enterprises. Vincent Montefusco took one example approach in creating a scent transfer unit. The Montefusco device is made up of a gas inflator with a gas cartridge. The gas inflator was coupled to an air amplifier that allows the gas from the cartridge to be expelled into this region creating a vacuum at the end of the amplifier where the gauze pad is securely placed. The novelty of the device lies in the use of the gas cartridge (carbon dioxide), which does not require mechanical parts and allows easy transport due to its lightweight construction (Figure 5.4).[3]

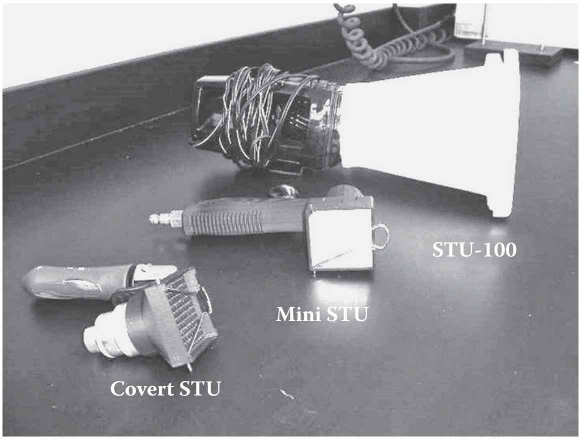

Figure 5.4 Different airflow scent collection devices. (Photo courtesy of Kenneth Furton.)

However, due to its compact size, the duration of the gas cartridge for continuous sampling makes it inconvenient for field operations as the cartridge needs to be replaced after every few runs. Hence, there are numerous current research efforts for the enhancement and development of optimized scent transfer units, which can be both practical in the laboratory as well as in rugged police/military field operations.

5.1.2 Laboratory Studies: Collection Materials

The International Forensic Research Institute (IFRI) laboratory has pioneered a number of research studies focused on scent collection methods. Distinctive methodologies, such as direct contact and noncontact approaches, but also specific scientific evaluations of devices such as the STU-100 for optimal collection parameters have been compared. A major focus has been devoted to the collection mediums used for this crucial step in the evidentiary process. Each law enforcement agency uses a different type of absorbent medium to collect human scent evidence. For example, the FBI uses Johnson & Johnson® sterile gauze while the Dutch National police utilize King's Cotton, which is a nonsterile medium. The analysis of human scent through both canine and instrumental means vary in the type of materials used and provide no rational for the selection of collection materials employed. Due to this lack of standardization as well as optimization of collection materials, different types of textiles have been studied to understand the trapping and release abilities of some of the most common types of fibers that could potentially influence the collection efficiency from a laboratory perspective.

Using the STU-100, the airflow rates that are observed when using various textile types in a scent collection scenario have even been evaluated. For these experiments, an in-house custom-built Modified-STU-100 sampling hood (known hereafter as the Mod-STU) was designed and developed from stainless steel in an effort to reduce contamination and enhance odor collection procedures. Airflow volume measurements were conducted at the low, medium, and high airflow speeds. The results are summarized in Figure 5.5. As can be observed, without any material present the STU-100 reaches approximately 538 L/min at the highest speed and 316 L/min at the lowest speed of the device. Both a gauze geometry (Dukal® cotton gauze) as well as common natural and synthetic fibers such as cotton, polyester, rayon, and wool were tested. The cotton gauze was the material with the highest reported airflow volume rates at all speeds evaluated followed closely by the pure cotton fabric. Thus, cotton materials yielded the largest airflow volumes when conducting noncontact sampling. The polyester fabric had the lowest airflow volume rates at all airflow settings which could explain a tighter weaving pattern in its structural composition and hence a greater difficulty in allowing the flux of air through the fabric.

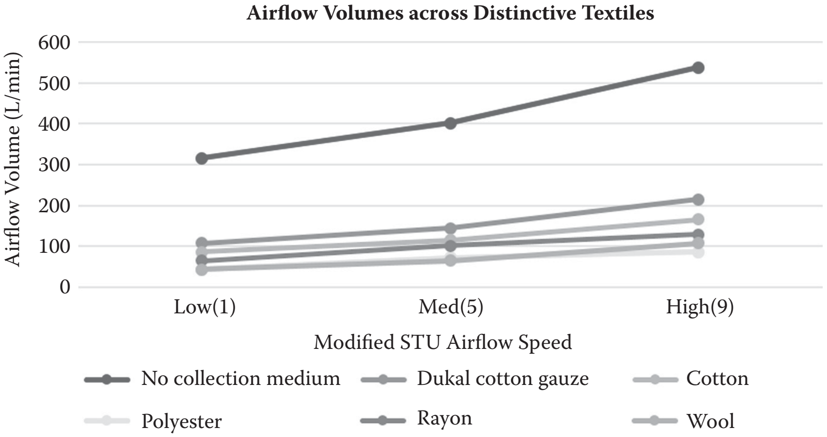

Figure 5.5 **(See Color Insert.)** Airflow volume measurements across different collection materials. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[4] With permission.)

To further validate the results, differences in fiber composition were further evaluated by performing scanning electron microscope imaging (SEM) to identify possible weaving pattern and fiber structure distinctions, which may affect the actual collection, retention, and dissipation of human scent (Figure 5.6). The Dacron polyester and rayon fabric exhibit similar

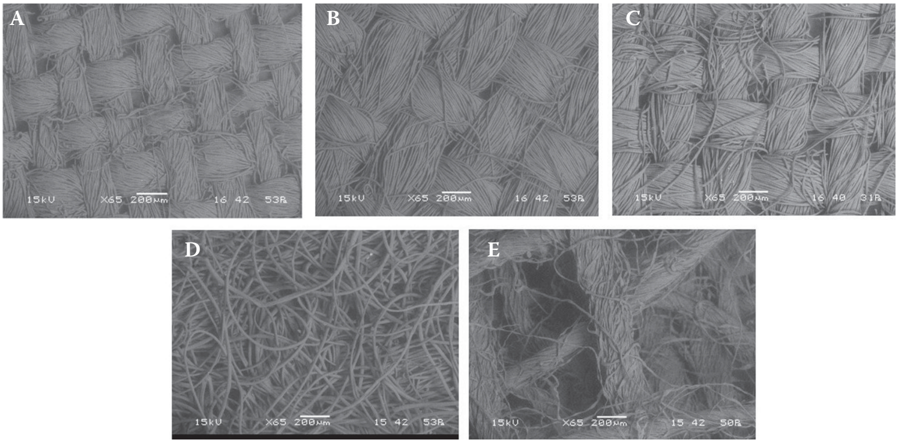

Figure 5.6 SEM images at 65× magnification of (A) cotton, (B) polyester, (C) rayon, (D) wool, and (E) Dukal gauze pad. (From Prada P.A, 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[4] With permission.)

weaving patterns, however polyester fibers depict a narrower, smoother finish when compared to the viscose rayon fibers. Cotton, polyester, and rayon can be said to have a tight woven structure, which may directly affect the collection of human scent by trapping the compounds in their weave and perhaps retaining odor for a more prolonged time. The wool woven structure is less structurally organized and is more like a mesh of fibers which when placed under higher magnification highlight the complex morphological structure of what seems to be animal hair structure properties. The Dukal sterile gauze pad illustrates a loose woven pattern when compared to all the other tested sorbent materials, thereby providing the most differing characteristics of weaving properties.

5.1.2.1 Textiles and Compound Retention

Studies evaluating human odor compounds in relation to collection materials for forensic applications are scarce and the majority of the research in this odor–textile interaction is in the textile industry. These studies focus on odor intensity as a function of fiber type in manufactured clothing. Studies conducted with cotton, wool, and polyester fibers have shown that polyester fabrics rate high in odor intensity while cotton and wool have mid-low odor intensity. Furthermore, the relationship between fiber type and odor was not affected by bacterial numbers present, although bacteria declined more rapidly on polyester fabrics than on either cotton or wool fabrics.[5–7] Other studies have focused on chemical retention on distinctive fiber types. It has been shown that adsorption is heavily influenced by chemical structure and hydrophobic interactions. The high polarity of cellulosic fibers, for example, can act as a driving force for the penetration of chemicals into the pores and voids of the fibers. Thus, the physicochemical nature of fibers (i.e., micropores, fibrils, surface, and secondary wall) play a key role in the ultimate retention and distribution of chemicals. Additionally, chemicals with low vapor pressures are retained on fabrics to a larger extent than chemicals with higher vapor pressures.[8–10]

Due to the highly complex interaction between skin microflora and glandular secretions, transfer of odor to a specific fabric type is not easily replicated or controlled in a laboratory. Hence, some objectives of the IFRI laboratory studies have been the evaluation of the retention and release capabilities of different textile types employing human scent compounds to reduce the influence of participant variation on the collected sample. Fabrics of both natural and synthetic origin have been tested using both direct contact and a dynamic airflow system in an effort to understand the retention and release of previously identified human odor compounds on various fabric substrates. Controlled odor mimic permeation systems (COMPS) were used to optimize the flow rate of the STU-100 with five different compounds of interest, furfural, 6-methyl-5-hepten-2-one, tetradecane, 2-furanmethanol, and dimethyl ester hexanedioic acid. The creation of a sampling chamber also reduced the amount of background contamination. It was concluded in this study that tighter weave materials collected a greater amount of compounds (fabric substrates used: Johnson & Johnson gauze, Dukal gauze, cotton, polyester, and rayon) and that higher airflow rates generally yielded lesser amounts of trapped compounds.[11] In other studies, a standard mixture containing up to 12 compounds of interest to directly spike each fabric substrate has been employed. The goal was to evaluate compound retention on pure natural and synthetic fabrics. The direct spike experiment showed how natural, cellulosic fibers such as viscose rayon showed an enhanced ability to release a reproducible volatile odor profile. Rayon demonstrated to be the fabric type with the highest recovered scent mass amounts, followed by wool and polyester. Cotton showed the lowest recovered amounts, possibly due to its complex fiber morphology, which enhances the possibility of chemicals to be retained in higher rates within the structure of the cotton fiber, and a longer time to consequently release them for detection.

A hierarchical clustering analysis was performed on all the samples spiked with the volatile organic mix to compare the similarity of the volatile odor profile in relation to fabric type. Figure 5.7 is a dendogram representing such statistical analysis. The more similar the profiles of two samples, the lower they are connected in the dendogram. In general, all five fabric types were clustered with samples of the same group. The most similar samples were both the clusters of cotton and polyester fabrics. There was also a clear clustering of both cotton fabric types, gauze and pure fabric, thereby showing the similarity of odor profile in both types of cotton samples. This confirms that samples collected on the same fabric are more similar to each other than to other fabric types. Hence, the importance of using a homogeneous fabric type when conducting live human odor collection. A careful consideration to variables such as airflow parameters when performing a scent sampling procedure also seem to play a key role in the instrumental evaluation of human odor samples.

5.1.2.2 Human Hand Odor Studies

Other studies conducted have entailed a direct comparison between scent collection methods, specifically direct contact versus noncontact approaches.[12] For this study, three men and three women were sampled, under the same lab conditions, using a specific textile per day for each subject. Four main fiber types were tested: cotton, polyester, rayon, and wool. For the contact sampling mode, the samples were analyzed after each subject had performed a prewashing step followed by a direct holding of the fabric between the palms of the hands. For the noncontact mode, the STU-100 was used as the collection device over their hands, hence evaluating the same body region.

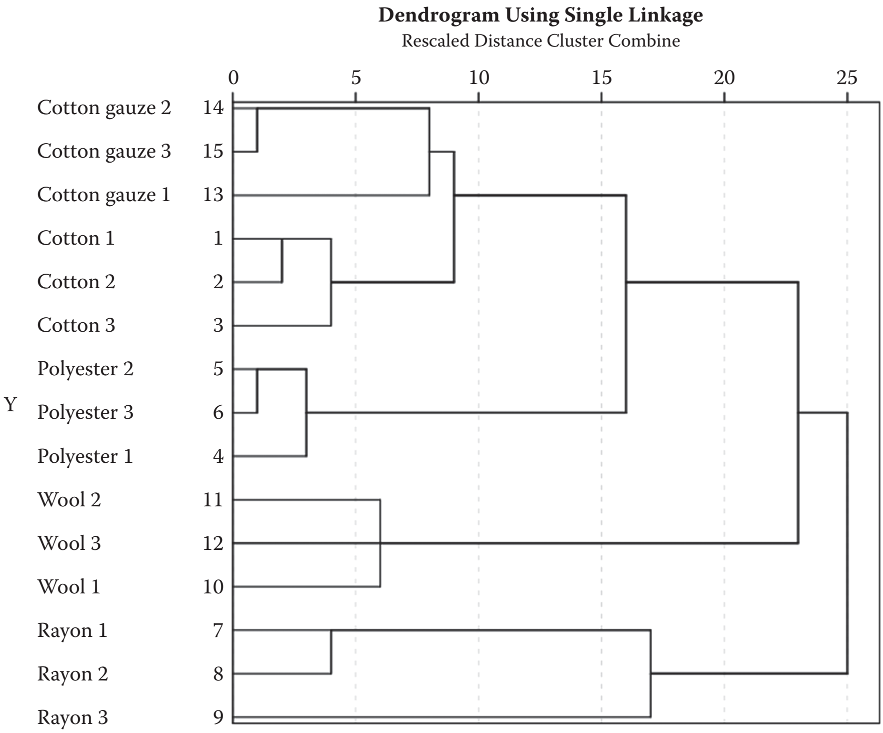

Figure 5.7 Cluster analysis dendogram of direct spiking experiment on different fabric substrates. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[4] With permission.)

The collected scent mass was obtained in highest amounts for both genders in cotton sorbent materials. The mass recovered compared to the noncontact sampling was up to 3× higher, showing via analytical techniques that an individual's observed chemical odor profile varies significantly depending not only on the method, but also on the material used to collect scent from the same location (Figure 5.8). A total of 58 volatile organic compounds (VOCs) were detected in the hand scent profiles from the six subjects by the contact method, compared with just 20 for the noncontact procedure. When each material type was considered as a group, using statistical tools such as Spearman rank correlations, it showed that cotton displayed the lowest amount of errors with distinguishability rates >95%, making this the best material choice for discrimination purposes. This comparison of both materials and methods is a step ahead in the optimization of scent collection procedures, not only in the lab, but also for a more informed choice of options in hands-on field operations.

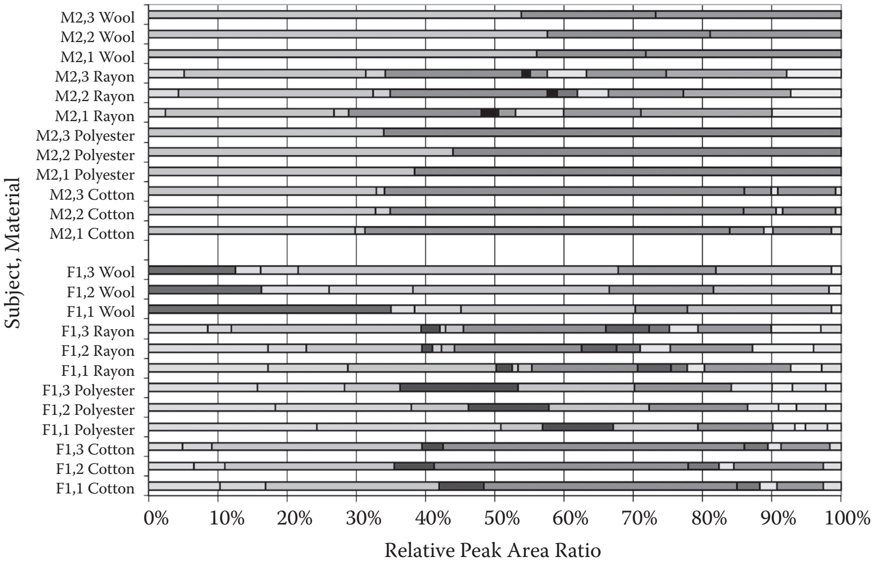

Figure 5.8 **(See Color Insert.)** Color odor chart for a female and male subject, primary odor per fiber type. (Reprinted from Prada P.A. et al., 2011, *Journal of Forensic Sciences*, 56, 878.[12] With permission from John Wiley & Sons.)

5.1.3 Police Work in Collecting Crime Scene Articles

As with other routine criminal investigation procedures, a canine handler must treat every situation with extreme caution, as the search being performed may be part of a legal prosecution. It is the handler's responsibility to conduct the mission with a proper chain of evidence. Common scent collection techniques have already been discussed, but a valid question is: Where is scent collected from? As every case is unique, and the scenario cannot be replicated every time, it is up to the handler's criteria as well as the investigative team to carefully analyze the particular scene to decide what makes up a good scent article. Good scent articles are those objects and/or surfaces that are less likely to be contaminated from other sources of odor besides that of the target subject. The more "personal" the object is to the target odor the better. For example, scent can be collected from personal hygiene products such as toothbrushes, hairbrushes, and feminine-hygiene products. Other objects may include dirty clothing (particularly underwear), socks, bed linens, chewing gum, cigarette butts, keys, cell phones, hats, computer keyboards, buttons, jewelry, doors, windows, door handles, and chairs. Scent articles may also be collected from biological specimens on the victim's body as hair, semen, blood, and even fingernails.[13] For suspect identification cases, other valuable scent articles are weapons left behind at crime scenes, expended bullet/shell casings, and even postblast pipe bomb fragments, to name a few.

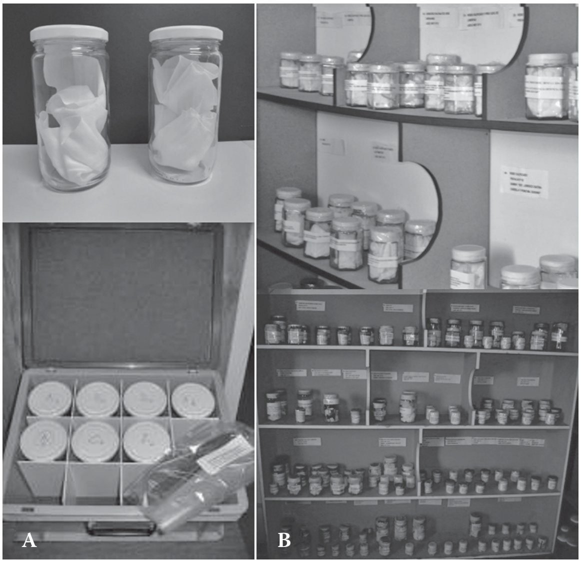

Figure 5.9 (A) Scent jars and case with material for scent ID line-up in Finland. (Photo courtesy of Ilkka Hormila, Police Dog Training Center, Hämeenlinna, Finland.) (B) Scent bank facility in Argentina. (Photo courtesy of Dr. Mario R. Rosillo.)

To further control contamination sources, the use of gloves for all scent collection procedures as well as the use of glass jars for containment of scent samples for prolonged periods of time is highly advised. The storage of these jars can then be in an organized toolbox or case for easier transport and reduced cross-contamination until the handler is ready to present the scent source to the canine. In systems having formal line-up units, these jars are stored in "scent banks" within the laboratory prior to scent discrimination procedures with the canines in the line-up room (Figure 5.9). A proper labeling of each item must be performed to ensure admissible handling of evidence items within the specific law enforcement jurisdiction.

5.1.4 Field Work in Scented Articles/Trailing

Precautions need to be given not only to the specific scent article from the crime scene or search area, but also to the beginning of the mission trailing activities. Extreme care must be taken to avoid unwarranted contamination such as those of family members, animals, and witnesses present at the crime scene. It is a very common practice to allow the canine to walk in front of other bystanders, family members, or staff from the investigative team to eliminate potential trails that he should disregard, even if they occur to be fresher than the one from the target. This is performed to allow the canine to "dismiss" these potential odor sources that may well be impregnated in the

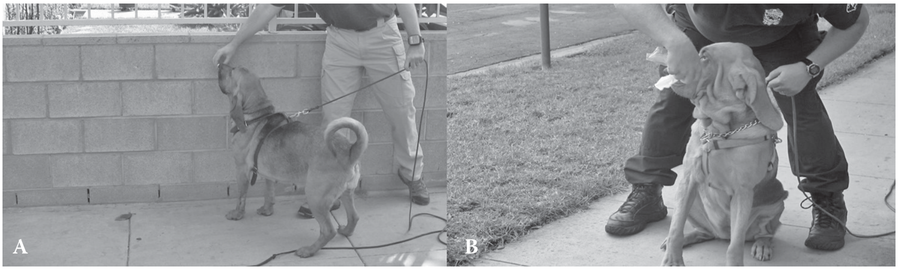

Figure 5.10 (A) Anabelle and (B) Bonnie getting a sniff off the scented article at a canine field exercise. (Photos courtesy of Paola A. Prada.)

search area or inadvertently in the scent article. Once this dismissal process is done, then the scented article can be presented to the canine. This scent source presentation needs to be carefully performed so as not to induce indirect aversion to the "game" of finding that target odor source.[14] Of course, every canine/dog team is unique, but this stage of the process is essential in the end result of the search. If the canine is not interested or does not get a good sniff of the presented article, the probability of a find is obviously diminished. (See Figure 5.10.)

Training methodologies are an integral part of the success of any trailing activity. This includes exposing the canine to a variety of terrains and scenarios that could be encountered in real deployment missions. Different search patterns must be introduced as part of regular maintenance and proficiency testing. As per Scientific Working Group on Dog and Orthogonal detector Guidelines (SWGDOG), it is recommended that, for an odor recognition assessment, one human target and one or two human distractors are used to lay human tracks or trails in an environment similar to the one where the canine usually works. The trail/track designs can be either cross-over or single split turns (Figure 5.11).[15] The S represents the starting point for the human target, while the F is the final point. In a cross-over design, the target makes two turns and his track/trail is crossed once by a fresher track/trail by the distractor. In the split turn pattern, the target track/trail joins two separate distractor tracks/trails, one fresher, one the same age. After a common part, the tracks/trails split up and the target makes a turn. Furthermore, the proficiency of a canine/handler team is demonstrated by performing double-blind testing, in which nobody, including the evaluator or the tester, know the correct outcome of the trail.

It is also important to incorporate negative checks during regular training routines. A negative check is essentially giving the canine a "blank" scent sample. The idea is for the canine to not respond to this scent source and hence not begin any trailing activity. When a canine begins to trail after given a blank, it could signify that the sample was contaminated with human scent present on the given trail and, hence, the canine responded to this scent

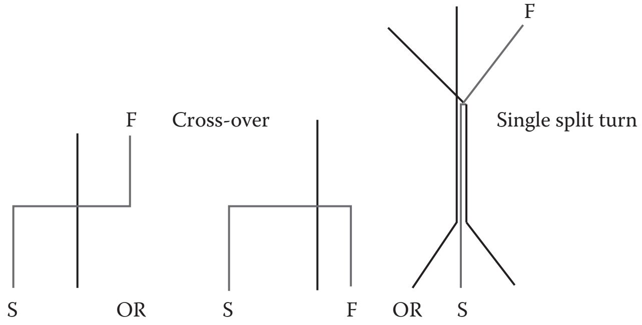

Figure 5.11 Trail search patterns. (SWGDOG SC9—Human Scent Dogs, Tracking/trailing people based on last known position (approved by membership 3/3/2010). Miami, FL: Scientific Working Group on Dog and Orthogonal detector Guidelines.[15])

source, or simply that the canine is not responding correctly. It is important to perform these checks in order to evaluate the canine, and adjust training methods to improve its reliability.

5.1.5 Field Work in Scent Line-Ups

Scent identification line-ups show a link between the odor of an object to that of a particular person. After following proper procedures for scent collection at the crime scene, these scent evidentiary items need to be stored and preserved with great care to guarantee the authenticity and integrity, allowing at the same time the certainty of other fundamental elements such as the confidentiality and validity of the legal proceedings. These scent trace items are carefully registered within the "scent bank" of the scent discrimination unit, within the particular agency conducting the line-up procedure. Hence, a strict organizational chain is required, limited to only certified personnel handling all incoming evidence items. These rooms need to have proper lighting, temperature, and ventilation so as to maintain optimal conditions for the preservation of scent evidence items. Even though different countries have slightly different operational systems, the general procedure is the same.

Once evidence items are recovered from the crime scene, the odor of the suspect(s) is collected as well as that of control subjects. In Europe, this is traditionally done using stainless steel tubes, or as in the case of countries like Argentina, this is done with sterile gauze material. Suspects and control subjects hold these materials for approximately 2 minutes.[16] (See Figure 5.12.) The scented material is then stored in glass jars, each subject having its own glass jar. As discussed in Chapter 1, the line-up is performed by first having the canine run a control subject odor, giving him an initial sniff of the control person's object (not the suspect). This is performed on two line-up rows,

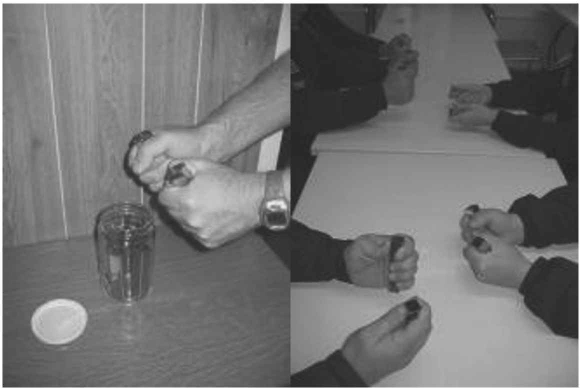

Figure 5.12 Scented material for line-up procedures in Finland. (Photo courtesy of Ilkka Hormila, Police Dog Training Center, Hämeenlinna, Finland.)

after which, if canine demonstrates positive results, the line-up continues using the suspect's odor as the target. This control step is critical, as the dog demonstrates the identification and does not show a particular interest in the tube of the suspect, which is also included in the control line-up.

Again, it is important to maintain the test blind to the handler so as not to inadvertently cue the dog's choice. Handlers are usually facing their back to the line-up, so as to control for cueing as well, and only reward when a green light appears signaling a correct choice.

Various experimental designs have been performed to monitor the reliability of scent line-up procedures. Experiments with six trained and certified Dutch police human scent tracker dogs demonstrated that an initial performance check prior to the forensic question had a significant positive effect on the results.[17] It was further concluded that the level of performance directly influences the reliability of the results, therefore if dogs are not able/willing to work, they should not be used in a forensic testing situation. The performance check step in the line-up, by where the canine is allowed two trials to select the odor of a control subject (prior to the suspect odor), is sufficient to test the olfactory ability of the dog. This olfactory ability can vary due to hormonal changes, illness, or day-to-day intrinsic variability. The simple check also tests for the willingness to work of the dog, eliminating possible mistakes made by unwilling dogs. In other studies evaluating the scent line-up, a modified design was tested, the even-odd paradigm.[18] In this study, the dogs were given odor 1 as the scent source. They were then trained to go to one tube on the platform, odor 2. If the odors matched (odor 1 = odor 2, even), the dog would then respond to this tube. If the odor did not match (odor 1 ≠ odor 2, odd), the dog would then go to another tube on the platform (a blank unscented tube) and respond. If proper responses were given, the dog would then be rewarded with a tube, or if the trial failed, no reward was given and the canine was recalled. Even though scent identification with this paradigm was more reliable, the complexity of the training merited changes to current working scenarios, demanding priority in training as well as long training and experimental sessions.

Another important variable in scent discriminating canines is the ability to correctly match scented objects of unfamiliar individuals even when these objects have been in direct contact with various body regions of the same subject. More than 700 scent samples were utilized in a study including both sexes and a varying age range. Canines were presented with scented cloths, which had been in contact with an unspecified body region and allowed to match on other body-scented cloths to identify the same target scent. The success rate was 80% correct match recognitions for this part of the experiment. Consequently, a further experiment allowed canines to match odor from various parts of the body with the hand odor of the same subject on clean steel tubes. The percent correct matches were 85%, thereby depicting the canine's ability to generalize individual human scents acquired from varying anatomical locations.[19] In a similar experimental approach, Dutch police dogs were capable of matching hand scent to scent collected on the crook of the elbow as well as matching trouser pocket scent to collected hand scent.[20] The odor recognition of the canines is definitely proven, however, one must accept the fact that variations of canine behavior may occur on any given trial thus implying the importance of repetitive training and performance checks for reliability in criminal operations.

For scent evidence to be of maximum use in a criminal investigation, it is important to take all precautionary measures in the collection and handling of evidence items and actual mission activities. An informed analyst and handler are the best assets when using this forensic tool, as any mistake during the processing may render the evidence unreliable and unaccepted in a court of law. This can only be achieved by following general guidelines for the correct procurement of scent evidence in any type of search scenario, and an educated investigative team who not only has an understanding of the technique but also of its limitations.

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Persistence and Stability of Human Scent

6

6.1 Human Scent and the Age Factor

> Smell is a potent wizard that transports you across thousands of miles and all the years you have lived.[*]
>
> **—Helen Keller**

Different aspects of human scent evidence have been examined in the past chapters, factors including the generation, collection, and historical developments of the technique. In Chapter 4, there was a focus on the transfer of human scent into the atmosphere. It was shown how environmental variables such as wind, temperature, or terrain dramatically impact the usefulness of scent traces in field applications. One major factor that was not approached, and which merits a proper discussion, is that of the durability and stability of human scent. Courts of law have continuously placed a heavy burden on this factor, as the utility of scent evidence lies in its availability when a canine performs a search. It makes sense, then, to pose a series of questions:

- How long does scent stay on a collected scent article?
- How about on a particular trail left by a fugitive or missing person?
- Does scent change over time? Or does it resist change and maintain its original odor profile? What can destroy it?
- What are the optimal parameters for proper storage and preservation?

These are all questions that have a direct link to the reliability of the technique, and hence an area of active research in both laboratory and field operative missions. Some insights into these types of questions and different approaches undertaken to find the answers will be provided. By covering some real-life canine work as well as various experimental designs, it will be highlighted that human scent is a viable tool even when subjected to extreme environmental factors such as heat and explosions along with the inevitable aging factor.

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[*] Keller H. (1908) *The World I Live In*. New York: The Century Co.

6.1.1 Scent Durability in the Field

As has been observed, defining human scent is not an easy task. It has many facets, layers so to say, that must be considered to get a thorough and reliable idea of its composition, transfer, and ultimate use. Every criminal investigation is different and the idea of replicating the scenario is just not feasible. However, as seen in Chapter 4, environmental parameters cannot be replicated but a general understanding of their impact on human scent does help understand any given situation. On a parallel level of thinking, time is of the essence in any canine search. The quicker the team is on the case, the better the chances for a successful result. However, it is difficult to measure or gauge how long scent will linger on a particular object or location, given the many factors that directly act upon the odor source. In practical tracking/trailing purposes, anecdotal evidence suggests that the best time frame for deployment ranges from 1 to 4 hours. It has been suggested that this is the most efficient time range for a canine to find a solid direction of travel, 12 hours being a good cutoff point for trail viability.[1] This does not mean in any way that canines are not able to trail older trails. The success of a canine search is heavily dependent on the odor availability at the given location and with the scented article. Effective maintenance training procedures also help canines conduct more efficient searches, even when environmental conditions or age are not the most optimal.

While canines are able to match odor in human scent identification lineups flawlessly with same day collected samples, the performance drops to a lower level and varies with time periods. Early work in the 1960s showed how lightly fingerprinted glass slides aged up to 6 weeks in indoor conditions were correctly identified and detected by dogs. When testing the same slides on weathered outdoor conditions, dogs had a much more difficult time finding human odor traces for the same length of time.[2] More recent experiments utilizing aged materials (from 2 weeks to 6 months) shows how canines demonstrated a drop in performance when using materials aged between 1 to 2 weeks. In general, the conclusions from these canine studies show that after an initial drop, aging the scent samples does not seem to diminish the odor recognition ability significantly. The initial drop in performance can be a direct link to the volatility of the odor molecules, since they do not evaporate at the same rate. Even if the same residue is left on two objects but at a different time, the headspace in both can be totally different if the residue components have differing vapor pressures. Since the scented articles are stored in glass jars, an equilibrium steady state develops, thus limiting the evaporation rate and explaining the leveling off in the performance when using older scent articles. The studies of latent fingerprints also validate this initial drop, as the majority of the compositional changes occur within the first week.[3] These observations have a direct effect on the generated headspace above the collected material, and thus the components which the dog might be using as a cue for identification. This initial drop then directly implies how storage protocols must be taken into consideration when handling and using aged scent samples.[4] In another field study, well trained trailing canines were used to follow human trails up to 48 hours old. This study was made with cross-trail contamination and under varying environmental conditions. It further supported the accurate use of the STU-100 as a sampling device to sample over the torso, arms, and hands of each individual, with no particular interest to a single body area.[5]

Perhaps the most solid evidence for the resiliency of human scent is that seen with canine work on postblast debris for scent identification purposes. The FBI along with the Southern California Bloodhound Handlers Coalition have conducted numerous studies as well as case work using human scent collected from bomb components and arson evidence. In March 2001, they used 12 bloodhound teams of varying age and experience for the study. Pipe bombs and arson devices were handled by the test subjects prior to detonation. The canine teams were brought to the scene 2 weeks later. A total of six test stations were set up in the Long Beach area, using blind trails in a split-trail format. The overall positive scent match result was 78.3%. Out of the canines that performed a positive match, 88.6% identified the correct target. In yet another study, the FBI tested if human scent survived irradiation procedures to remove biological agents. Using scented paper as the matrix, the odor samples were irradiated with average doses of 40.7 kGy and 39.5 kGy for 1 hour. On all six trials performed, all of the bloodhounds were able to trail to and correctly identify the target corresponding to the specific scent pad. In the second part of the same study, it was also tested to see if chemical contamination deteriorated the scent picture. A 10% sodium hypochlorite solution was sprayed onto the sheet of scented paper, and the four bloodhounds tested indicated the presence of the matching scent, correctly identifying the targets.[6] These two studies corroborated that chemical or irradiation procedures are not enough to destroy the scent used by canines in identification exercises.

An additional feasibility study by the FBI corroborated the survivability of human scent after thermal changes. Twelve test subjects were selected and allowed to handle materials used for the construction of four pipe bombs using two low-explosive powders and two high-explosive materials. Following the explosions, scent pads were collected from the pipe-bomb debris by placing the fragments on the STU-100 (Figure 6.1). The study demonstrated the survivability of human scent, which was still usable to the canine to make a positive scent match even after undergoing violent thermal conditions reaching temperatures that exceed 5000 K in detonating explosives.[7]

The IFRI laboratory has also conducted studies in collaboration with the FBI and the Marine Corps Military Working Dog program to test the

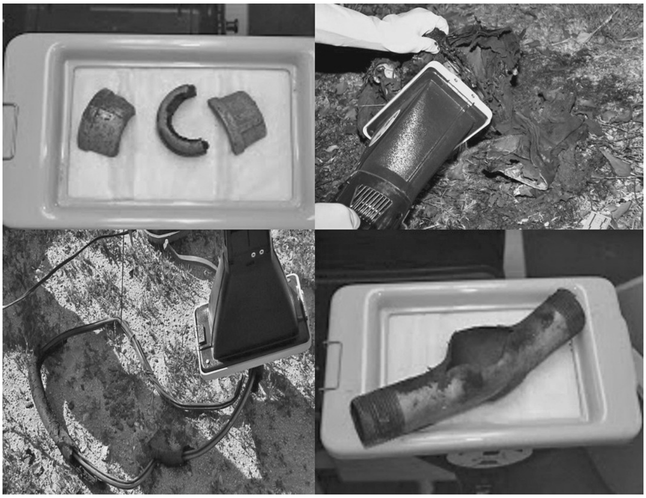


Figure 6.1 (See Color Insert.) An STU-100 scent collection from a detonated bomb and arson evidence. (Photos courtesy of William Kift.)

survivability of human scent in both peroxide-based explosions as well as simulated roadside improvised explosive devices (IEDs) using double-blind testing paradigms.[8] Due to the ease of manufacture, hazards, and increased use of peroxide-based explosives, this field test was the first of its kind to evaluate human scent canines using peroxide-based debris as the scent source. A total of 13 canine-handler teams participated in the study. The study was divided into two main sections, a peroxide-based car bomb device and a roadside device. For the peroxide-based device, the explosive material was placed in the front passenger floorboard of a pickup truck, along with a nylon bag and simulated IED componentry (i.e., wires, duct tape, alligator clips). The target subjects were allowed to handle the nylon bag and IED componentry (Figure 6.2) as well as vehicle parts such as the steering wheel, driver's side mirror, and door, to make the simulation. Both target subjects then walked into the village, approximately 0.5 miles from the detonation site. In order to add complexity and realism to the test, an additional six people were placed in the experimental area as decoys while the teams were running their trials. Hence, this proved that a canine was performing an identification scent match and not just simply an identification of any individual on the scene. The canine teams were started at the front bumper of the truck, with no further indication on direction of travel by targets (Figure 6.3).

For the second part of the study, the roadside device was placed 15 feet from the passenger truck inside a hole dug by hand approximately 4 inches deep. Once again, prior to detonation, the insulated pouch and componentry were handled by two target subjects. Both subjects walked different paths into the surrounding village. However, one of the subjects was taken to another

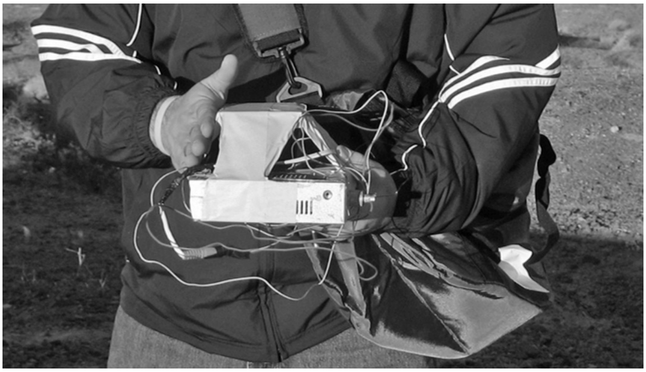


Figure 6.2 Direct contact with IED componentry during field exercises. (Photo courtesy of Kenneth Furton.)

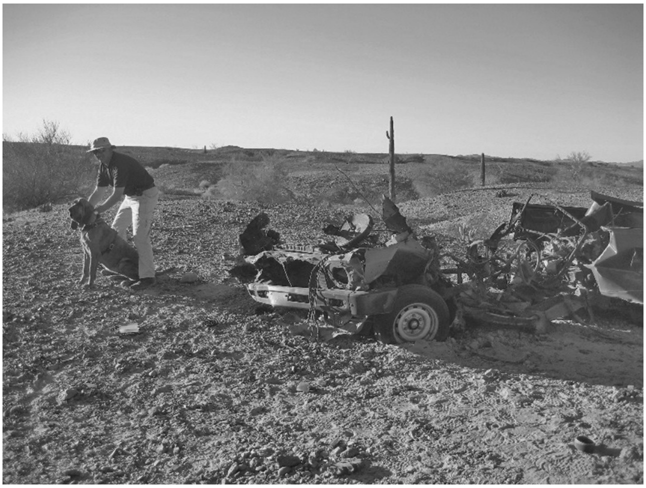


Figure 6.3 Canine team getting ready for trailing exercise at a peroxide-based vehicle blast site. (Photo courtesy of Kenneth Furton.)

location from the blast site (a stationary bus) prior to entering the village. For canine trailing activities, teams were started at both the blast site, as well as the bus location, to evaluate the different target locations. Once again, decoys were present during the trailing exercises to add complexity and realism. Combining the results from the peroxide-based car bomb and the first experimental part of the roadside device, there was an average success from site response of 82.2%. Incorporating all sections, there was an overall success rate of 73.5% from the participating canine teams. This experiment showed the value and potential of human scent discriminating canines as first responders on improvised explosive device detonation sites.

6.1.2 Laboratory Perspectives on Scent Stability

Field exercises provide some pivotal demonstrations of the reliability of human scent discriminating canines in real investigative and military applications, however, laboratory work is key to corroborate and provide foundational aspects to these results. Experiments have been geared to evaluate collected odor samples over time, as well as evaluating optimal preservation materials and environmental parameters.

Initial experiments evaluated the reproducibility of the collected hand odor profiles across 50 days using cotton gauze material. Using statistical tools such as Spearman rank correlations, the data supported the hypothesis set forth through canine work that human odor is stable over time.[9]

The evaluation of three sorbent materials (cotton gauze, cotton fabric, and polyester) was performed to monitor the reproducibility of a collected human scent sample, within each material type, during just a 4-week period (Figure 6.4). In addition, the stability of a human scent sample on a sorbent material was monitored over a 1-month period to evaluate the material's ability to retain an initial human scent profile. For the reproducibility study, triplicate samples with each material type were collected from a female subject over a 4-week period. For each triplicate set within each material type, a set of primary VOCs was selected to represent the chemical odor profile for the female subject. The preliminary results show that using the cotton fabric yielded to recurring compounds such as nonanal, decanal, and 6, 10-dimethyl-5, 9-undecadien-2-one in all of the samples collected over the 1-month study. The scent mass amounts ranged between 221–283 ng. For the cotton gauze, the collection of samples over the 4-week span also showed nonanal, decanal, and 6, 10-dimethyl-5, 9-undecadien-2-one in all of the samples as well as hexadecane. The scent mass amounts reported for this material ranged from 141–227 ng, thereby showing a slight decrease as that observed with the fabric material. Compared to the fabric, the cotton gauze did not have any alcohol type of compounds in the odor profile thereby reinforcing the results obtained with the pure standard compounds in which there are differences observed based on the material employed. As for the polyester fabric, the primary odor compounds was reduced to about six to seven compounds per weekly sampling. Ketones such as 6-methyl-5-hepten-2-one and 6, 10-dimethyl-5, 9-undecadien-2-one were detected across all weekly samplings, as well as decanal. The scent mass detected, however, was the lowest reporting amounts in the range of 26–73 ng. The relative area distribution was also the least reproducible when compared to the ratios observed with the cotton materials.

Preliminary stability studies were conducted by collecting triplicate hand odor samples from Female 1 with each of the above-mentioned sorbent materials. Each of the sets of samples collected was stored under regular room

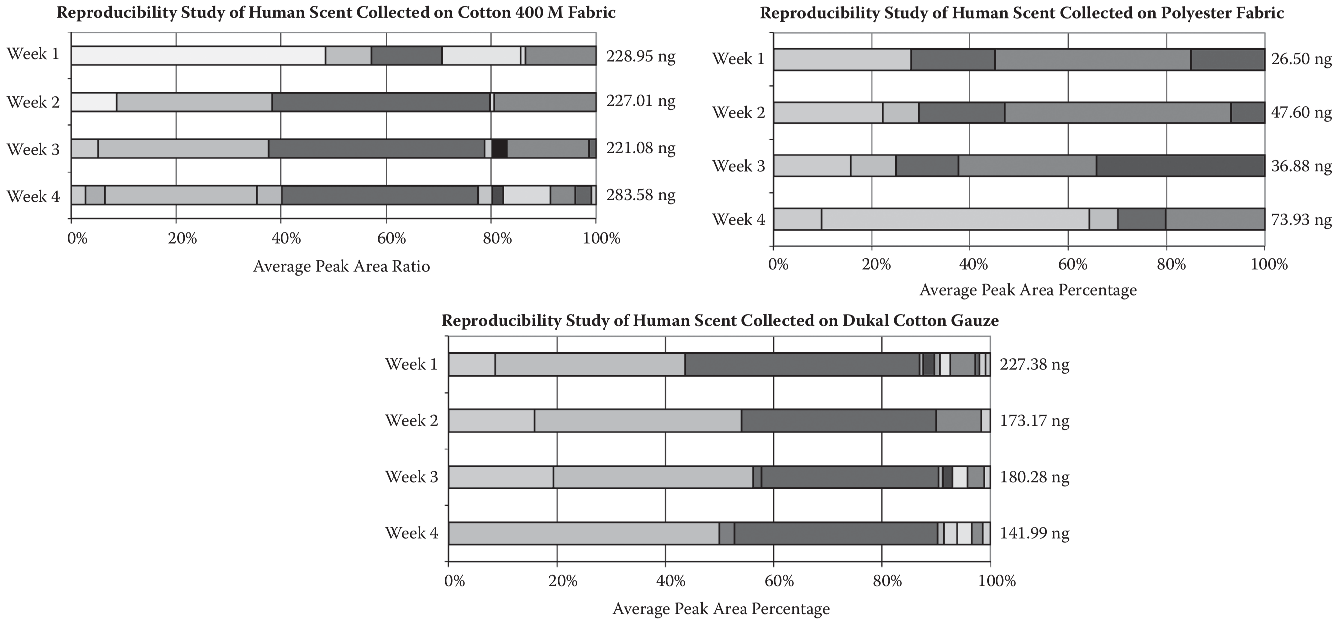


Figure 6.4 **(See Color Insert.)** Reproducibility study of collected hand odor from a female subject on three different sorbent materials. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[10] With permission.)

temperature conditions for a period of 1 month. The ratios of VOCs present in the headspace were monitored via SPME-GC/MS at weeks one, two, three, and four. All studies were performed by making multiple headspace extractions from the same vial over the 1-month period.

From this experiment, it was determined that as time progresses, some VOCs originally present in the primary odor profile of the subject were no longer being detected (Figure 6.5). A reason for these changes could be due to depletion of the headspace when performing multiple extractions on the same sample. In addition, initial evaporation rates of particular compounds could result in changes during the first days of storage. However, in cases where there is only one sample this experiment serves as a foundation to monitor such instances. As expected, there is a decrease of scent mass as more extractions are performed with Dukal cotton gauze being the material with the highest mass across the 1-month period (Figure 6.6). When comparing only the fabric types (cotton and polyester), polyester proved to be the material with the lowest scent mass amounts as well as the lowest number of reported VOCs above the headspace. Confirming the results obtained in the reproducibility study, polyester seems to be a nonoptimal material for the prolonged storage of human scent samples due to its minimal capacity to provide reproducible profiles as well as a lack of ability in retaining VOCs after time.[10]

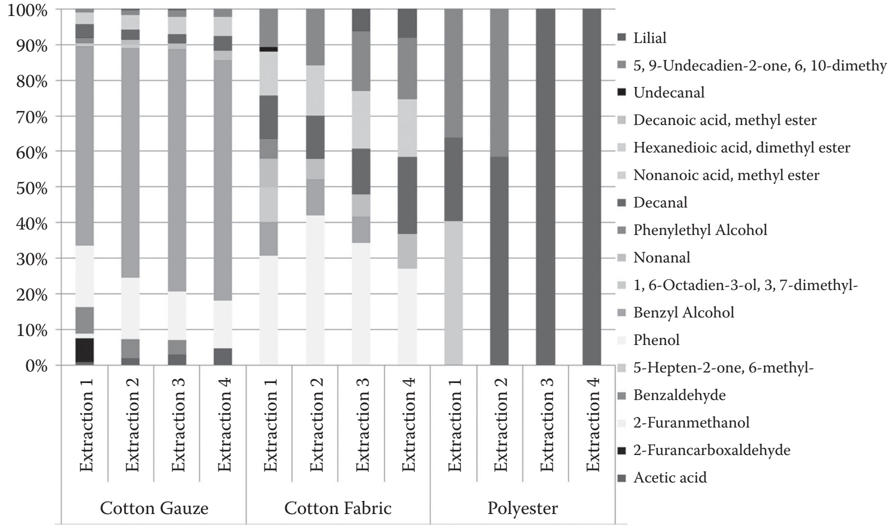


Figure 6.5 **(See Color Insert.)** Stability of human hand odor for a female subject. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[10] With permission.)

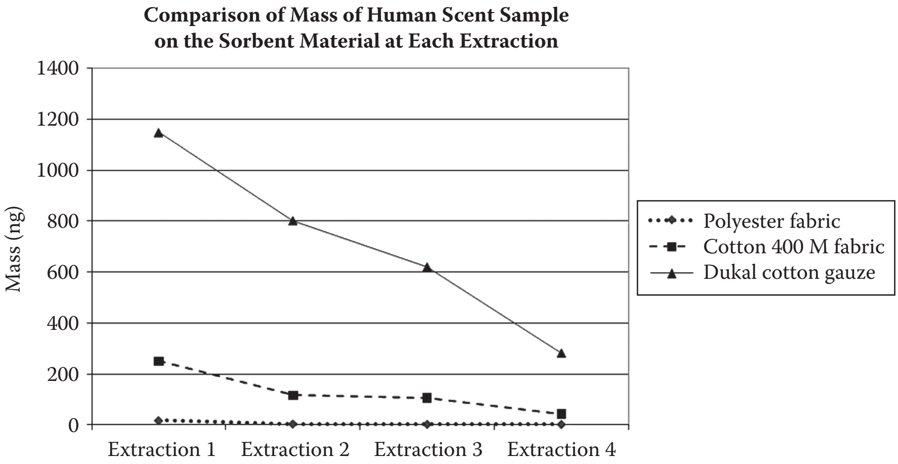
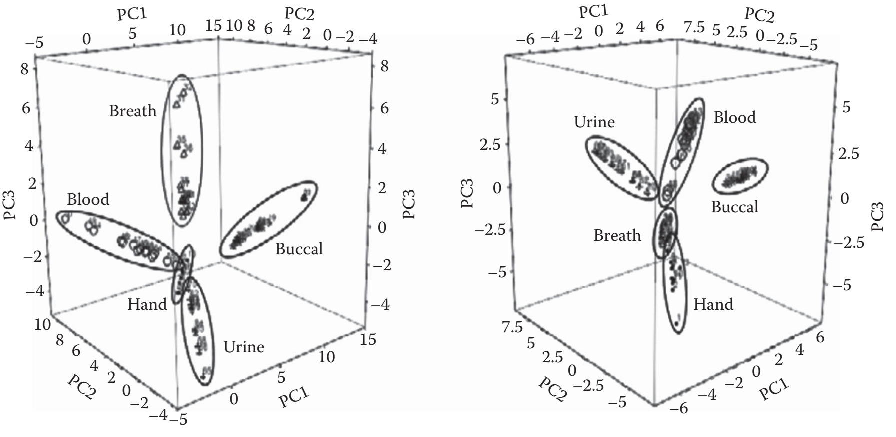


Figure 6.6 Representation of scent mass detected for multiple extractions of a female subject. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[10] With permission.)

Evaluating not only hand odor, but also other biological specimens (urine, buccal swabs, breath, blood), longer time periods for the evaluation of odor profiles have been embarked on. A pilot study was conducted using two unrelated subjects (female and male) over a 6-month period for a closer look at their chemical profiles over time.[11] Using Spearman rank correlations to measure their similarity over time indicated that specimens such as buccal swab odor had the highest consistency. Further analysis of the data shows that the VOC profiles of one individual taken over a period of time is not as variable as that observed between individuals. As can be seen from Figure 6.7, principal component analysis shows how VOC profiles from the same specimen over time group together. This study shows via a scientific approach that a generated chemical odor profile is viable to be stable for prolonged periods of time. Even though it is not known exactly which odor molecules the canines use for identification, this is a good indicative that a baseline primary odor profile for a specific subject is always present, regardless of environmental, diet, or lifestyle variables.

Another critical area of concern in stability studies lies in the proper preservation of the scent samples. Hence, studies have been conducted in controlled laboratory conditions to monitor some of these concerns. Storage containers of different composition (i.e., glass, polyethylene, and aluminized pouches) were tested to determine optimal mediums for scent preservation.[12] Sterile and pretreated gauze pads were sealed into five types of storage systems which included: 10 mL clear screw top glass vials, Ziploc freezer guard

	Hand Odor	Buccal Swab	Breath	Blood	Urine
Female 4	0.717–0.976 (0.259)	0.820–0.967 (0.147)	0.626–0.952 (0.326)	0.771–0.943 (0.172)	0.400–0.980 (0.580)
Male 5	0.717–0.983 (0.266)	0.769–0.55 (0.186)	0.486–0.943 (0.457)	0.400–0.967 (0.567)	0.260–0.920 (0.660)



(a) (b)

Figure 6.7 Stability of biological specimens over a 6-month period: (a) female (b) male. (Reprinted from Kusano M. et al., 2013, *Journal of Forensic Sciences*, 58(1), 36.[11] With permission.)

plastic bags, KPAK heavy duty seal pouches, KPAK aluminized pouches, and polyethylene pouches. For the pouches, a heat seal was used to guarantee a complete seal of air and outside contamination. These storage systems were evaluated at 1-, 2-, and 5-week periods, at which point they were introduced into their original glass vials for instrumental analysis via SPME-GC/MS. Data results showed that the container which introduced the least amount of contamination to the sterile gauze pads was the glass vial. (See Figure 6.8.) In terms of an analytical perspective, a low background is optimal for detection purposes. For canine use, the level of background contamination may not be as critical, however, exogenous compounds from collection materials should be limited as they could inadvertently alter the scent profile and thus have indirect effects on canine performance.

Other storage parameters evaluated in this same study were environments such as room temperature, freezing conditions, dark, and UVA/UVB light exposure during a 7-week period. The studies evaluated three different gauze collection materials for the hand odor samples. In general, for all materials and conditions the greatest variation in scent profiles were observed between week 0 and week 3, as determined by three-dimensional covariance mapping. At the −80°C condition, the 100% cotton materials showed more variation than the blended cotton/polyester gauze blend. In addition, the results show that scent samples should not be exposed to excessive amounts

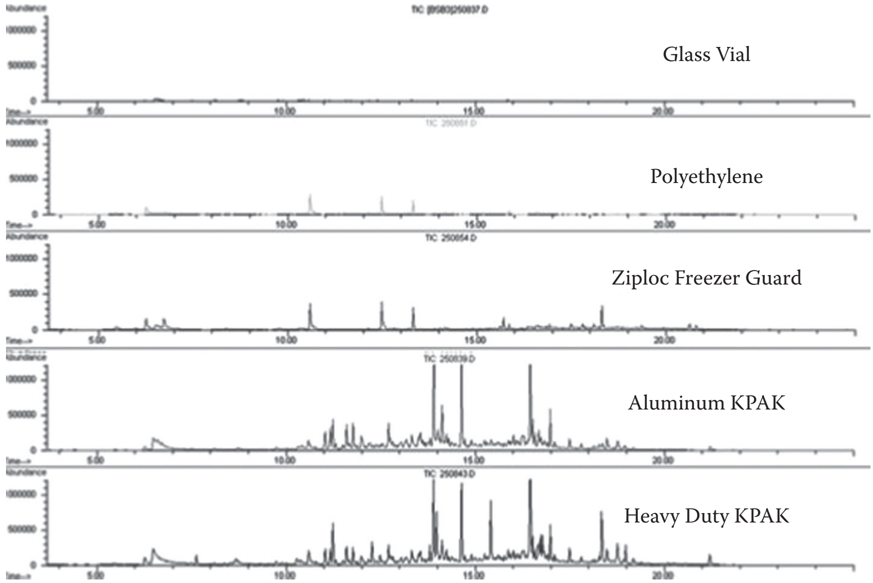


Figure 6.8 Different storage containments for clean gauze material: 5-week storage period. (Reprinted from Hudson D.T. et al., 2009, *Journal of Forensic Sciences*, 54, 1270–1277.[12] With permission.)

of UVA/UVB light as this results in enhanced detection of methyl esters and aldehydes above the headspace of the scent samples.

As can be seen, from both practical canine work and laboratory experimental designs, the stability and reproducibility of human scent has been demonstrated via different approaches and poses to be a great advantage when it comes to canine scent discriminations. Of course, different cases always bring unique questions that need to be examined, but the foundation and the potential of human scent persistence has been clearly established.

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Human Scent Canines

7

7.1 A Variety of Scent Discriminating Canines

> He is your friend, your partner, your defender, your dog. You are his life, his love, his leader. He will be yours, faithful and true, to the last beat of his heart. You owe it to him to be worthy of such devotion.
>
> **—Author unknown**

From the early history of human scent line-ups in Europe to the production, collection, transfer, and use of human odor traces, we have shown the value of this trace evidence in a forensic setting. This journey has also highlighted that the definition of human scent is complex, and cannot be summarized with a simple phrase. Its sources are numerous and depend on a number of both internal and external factors. Nevertheless, human scent proves to be useful to our four-legged biological detectors in many operational situations. The usefulness of such human scent evidence has to be limited to those dogs able to demonstrate a proficiency in a number of areas. It is the goal of this chapter to serve only as a brief description to a number of these human scent applications, as some categories such as search and rescue and human remains detection have whole books dedicated to them. We hope to highlight the basics so that both the novice and expert reader can appreciate the range of situations where human scent can even save a life.

As mentioned in Chapter 1, due to the lack of national standardization procedures in the performance of detector dogs, efforts have been made to develop optimal operational guidelines in the different areas of scent detection missions. In 2004, a scientific working group (SWG) was initially drafted for detector dogs and orthogonal detectors (SWGDOG) similar to that employed in other technology areas (i.e., bloodstain pattern, anthropology, DNA methods). For more than 20 years, federal agencies have supported the efforts of these scientific groups for the advancement of forensic standards and techniques. The mission for SWGDOG is to discuss and share ideas regarding methods, protocols, and research, while simultaneously bringing organizations/individuals together in developing relevant standards.[1] At the same time, the membership recommends and disseminates consensus-based best practices guidelines through the establishment of different subcommittees designed to attend to the different needs of the detector dog community such as: terminology, general guidelines, selection of serviceable dogs, kenneling and health care, selection of handlers, presentation of evidence in court, research and technology, substance detector dogs, human scent dogs, and outreach and education. In this chapter, the different types of human scent discriminating canines following the categories outlined in the SWGDOG guidelines will be explored. It is relevant to emphasize that there is a difference between canines used to trail human scent, perform scent identification line-ups, recover victims in disaster environments, and even locate decomposing bodies. The many facets of human scent canine/handler team missions will be highlighted to provide a general and concise overview as to requirements for each operational activity as recommended in the guidelines for various scent detection categories.

7.1.1 Article Search

The article search is the area of scent detection that is employed to search areas (typically close to the crime scene) for human-scented articles that were either thrown away or left behind unintentionally. As observed in Chapter 4, human bodies are constantly transferring air currents along with rafts into the environment, thus contaminating objects an individual touches with rafts, bacteria, and skin oils. Following proper scent collection techniques (Chapter 5) allows scented articles to be of great value to criminal investigations. As per SWGDOG guidelines,[2] initial training should include a variety of articles expected in an operational search such as handguns, tools, credit cards, keys, and so on. It should also include different types of environments so that scent recognition assessments can demonstrate the ability of the canine to indicate human-scented articles. Scented articles should be handled for a minimum of 30 seconds prior to being placed in the designated search area. An area that is at least 150 square meters is recommended with a minimum of four scent articles. A canine must be able to locate at least 75% of the human-scented articles and give the trained response (either active or passive alert), which the handler must identify. Double-blind assessments (in which neither the handler nor the evaluator knows the correct outcome) are recommended for canine team proficiency as well as regular maintenance article search training.

7.1.2 Avalanche Search

Another important detection area of human scent canines is that of avalanche searches. These canines are used to locate victims trapped in snow in locations such as ski areas, wilderness, and villages/towns affected by snowstorms. The canine covers the search area independently and gives a recognizable alert (either passive or active) upon locating the target(s). Even though Europeans have employed avalanche search dogs since the 1930s, it was not until the 1960s that the United States used canines for this scent detection capacity. In 1969, Jean Syrotuck's dog was the first American-trained dog to make an avalanche find on a victim buried under 7 feet of snow in Mt. Rainier.[3] In these types of training search scenarios, practice victims are buried in shallow holes in early training sessions, while adding depth as the training progresses. Having an area free of other human scents beside that of the victim is not possible, therefore the avalanche search dog must be able to detect the low intensity of a victim's scent trace coming up through the porous snow and discriminate it from other human scents surrounding it. Every canine develops a distinctive alert and digging response, thus the importance of the handler's interpretation of their canine's behavior. In avalanche search missions, canines can indicate different places, giving several alerts, thus handlers should pay attention to the geography of the snow and cracks to determine the most efficient approach. They should also be aware of the potential for more avalanches, focusing work at a rapid tempo and with extreme caution at all times.[2]

Even though little research has been conducted on environmental factors and scenting conditions for avalanche search dogs, a recent study by Ryan Gould at Alaska Pacific University shows handler perceptions for optimal scenting conditions.[4] In this study, 61 handlers from different regions in North America identified and ranked factors that affect scent in these harsh conditions. Their collective experience totaled over 1500 rescue training sessions and more than 350 avalanche missions. Findings from this study highlighted that light to moderate winds, no or little snow on top of soft slab, with moderate (10–20°F) air temperatures in open terrain are the most optimal environmental parameters for a search mission. Both hard and wet slab hinder scent movement through the snowpack, while soft slab allows the permeation of scent through the porous snow surface more readily. Also, handlers concur that open terrain provides the easiest scenting environment, while forested terrain makes the search more challenging. These results are some of the first efforts to provide a baseline on handler understandings that play a significant role in avalanche work.

According to SWGDOG guidelines on avalanche search canines,[5] initial training should include topics such as search planning techniques, scent dispersion, first aid and CPR for canine team, target(s), and victims, mountain rescue, and avalanche awareness, to name a few. Canine handlers should also be trained to use equipment such as probe poles, shovels, radio protocols, and GPS systems. The canine team is also recommended to be exposed to an array of different locations, situations, and even modes of transportation (i.e., helicopters, chairlift, snowmobile, snow shoe/skiing) commonly encountered when working avalanche missions. Suggested odor recognition assessments are delineated with the purpose of evaluating the canine team's ability to indicate on live subjects only and not on nonhuman distractors. The recommendation consists of a search area with a minimum of five snow caves/holes in an area of approximately 1000 square meters. The inclusion of two blank caves, as well as snow caves with nonhuman-scented distractors (i.e., ski equipment, food) is also recommended for the search parameters. Comprehensive assessments to test the level of competence is also recommended on search areas approximately 4050 square meters in size, with simulated human contamination for a search time not exceeding 20 minutes. Of course, certifying agencies might vary some of these parameters depending on regional terrain and other agency specific protocols. As with any other detection mission, proper maintenance training is to be conducted on a regular basis for optimal operational proficiency.

7.1.3 Prescented Canines—Location Check

Location checks are one of the most commonly used detection categories of human scent canines for criminal investigations. This method uses positive and negative scent checks to aid investigators throughout a case. Canines are used to identify a scent association between a person and a given location (i.e., residences, business, or other areas). Canines are used to scent match a "prescented" object or pad to the scent present at the check site. For example, in investigations where there are a number of potential suspects, canine location checks can be used to determine whether there is a scent association between a specific suspect and a piece of evidence collected from the crime scene. When a location of interest is identified in the course of the investigation, investigators can use a scent dog to check other locations where the same suspect is known to have been. (See Figure 7.1.) In this manner, the investigation can rule out suspects, with corroboration of other forensic/investigative techniques. It is important to note that a lack of a scent match is not a full guarantee that the suspect has no relationship to the crime, hence as with all scent evidence use, it must be employed knowing its limitations as well.[6] A variation of the traditional location check is that of station identifications. Investigators can bring a suspect into a police station for questioning or custody. The suspect's trail is documented for the record. A canine team is brought to the station, giving the canine the scent evidence from the crime as the starting scent source. A scent match will yield to the canine following the path traveled by the suspect within the station, and final identification of the suspect by the canine. A negative scent match will be the dog's refusal to trail. However, contamination issues must be considered as the presence of crime scene staff or investigators can present cross-contamination of scent sources.[5]

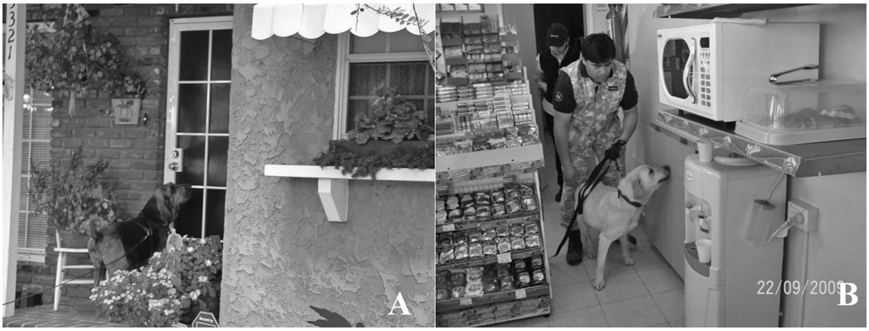

Figure 7.1 Location check in (A) a California residential area. (Photo courtesy of Paola A. Prada.) (B) Store location, canine sniff where suspect leaned, Argentina. (Photo courtesy of Dr. Mario R. Rosillo.)

A case example of a successful location check is that conducted by the FBI's human scent evidence team in 2002.[6] In this particular case, a pipe bomb exploded inside a car in the Washington, DC area, injuring the 21-year-old driver, Wright Sigmund. The half-brother (Prescott Sigmund) of the victim disappeared shortly after. Seventeen days after the bombing, and with no prior knowledge, using scent collected from the pipe bomb fragments, the dog team alerted on the front door of Prescott Sigmund's house. The team then performed a location check at the metro station where the suspect's car had been abandoned. The check of the subway entrance was negative. The handler deducted from the canine's behavior that the suspect must have left the station by bus or had been picked up. Months later, Prescott Sigmund turned himself in and admitted that he rode a bus out of town, thus confirming the location check results by the canine team.

As with any other mission, location checks entail regular maintenance training and a structured curriculum for this specific objective. SWGDOG guidelines recommend that handler training incorporate scent dispersion theory, proper scent collection techniques, and interpretation of location checking. Canines should be able to perform effective and controlled searches, with canine team assessments to evaluate proficiency. Comprehensive assessments for this mission should also use trails with a minimum of 45 meters, and should be completed in less than 5 minutes, with at least 80% of the location checks being performed correctly. Double-blind assessments are also highly recommended to demonstrate proficiency in operational settings.[7]

7.1.4 Nonspecific Human Scent Wilderness Area Search (Air Scent)

This type of scent detection category is employed to locate live people in unpopulated wilderness areas through the use of air scent by a trained canine team. Airborne scent is heavily concentrated near its source, and following air currents, becomes diluted the further it travels (i.e., scent transfer theory and patterns as discussed in Chapter 4). Air scenting canines are said to follow the trail of an individual with their head up in the air, following scent rafts being carried by wind currents. The difference between air scent canines to that of tracking dogs is the behavior of the canine while following the odor trail, as they do not follow ground disturbances or surface characteristics.[8,9] This type of search mission is critical to finding missing persons in rural/farmland areas, for elderly persons who have wandered off, in heavy bushes around lakeshores, or for children who may be hiding in forest areas, to name a few operational examples.

SWGDOG guidelines for this search category recommend initial handler training in areas such as search techniques and tactics, odor dispersion theory, first aid for canine and subject, as well as online National Incident Management System (NIMS) classes. Odor recognition assessments are recommended to consist of a single search in an unpopulated environment with a search area of approximately 20,000 square meters in size, and with one target walking into an area encouraging the use of air scenting. Search time should be approximately under 30 minutes. For comprehensive assessments, the search area should be 0.16–0.24 square kilometers, using one to three targets. The canine must be able to locate and perform its trained final response on the target(s) present on the given search area. Again, double-blind assessments are recommended for ultimate proficiency evaluation.[10]

7.1.5 Prescented Canine—Aged Trail Search

This scent detection discipline uses human scent canines to search and follow aged trails of a specific target's scent over different surface types. For this search mission, canines are "prescented" with an object (scented article) containing the target's scent. The canine works from this article to either the person or a location associated with that person. The objective of this specific search category is to detect and efficiently use a person's scent trace on a given article and either search a matching scent trail or yield a negative matching trail response. This category of scent detection is not used in immediate apprehension functions.

SWGDOG guidelines in this search mission recommend initial training to include scent articles, aged scent, trail distances, and a variety of locations to simulate operational activities. Handler training should also include human scent behavior and collection, as well as relevant canine case law and legal presentation of evidence. Odor recognition assessments are recommended to consist of four individual assessments, each having a human target and two other human distractors to lay scent trails in environmental conditions similar to those where the canine commonly works.

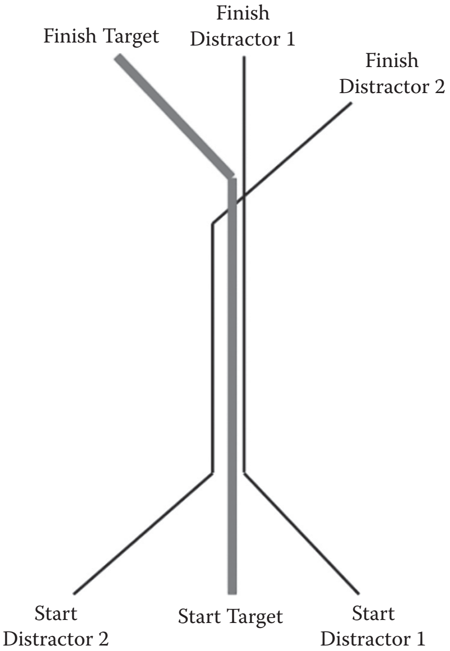

Figure 7.2 Schematic of SWGDOG recommended single split turn trail design for odor recognition assessments in aged trail searches. (Data adapted from SWGDOG SC9—Human Scent Dogs Pre-Scented Canine—Aged Trail Search (approved by membership 9/15/2010). Miami, FL: Scientific Working Group on Dog and Orthogonal detector Guidelines.[11])

The recommended length for these trails is between 90 and 183 meters with single split turns (Figure 7.2). Also, at least half of these assessments must include negative controls to demonstrate the ability of the canine to detect the absence of a matching scent in the environment. In these odor recognition assessments, the canine team must correctly discriminate at least 75% of the scenarios presented. For further comprehensive assessments, one or more target subjects can be used with trails of approximately 1.6 km, and aged to a minimum of 12 hours. The target trails in this level of evaluation are recommended to contain at least 10 turns, with multiple human distractors within the search area. Proper maintenance training is recommended as well as double-blind assessments for ultimate proficiency evaluations.[11]

7.1.6 Scent Identification Line-Ups

Scent identification line-ups have played a pivotal role in criminal investigations throughout Europe and more recently in the Western hemisphere. As discussed in Chapter 1, the history of the scent line-up traces back to the mid-1900s in the Netherlands, where canines were asked to smell articles collected from crime scenes and select the matching odor from objects worn by suspects.[12] A scent identification line-up procedure presents an association between the scent evidence and a suspect. Scent line-ups are conducted in controlled laboratory conditions where the specially trained canine sniffs the scent sample collected from the crime scene and compares that scent with those scent samples taken from the suspect and reference persons. It is important to highlight that the canine points out to an association (or lack thereof) between the crime scene scent sample to that of the suspect but this does not equate to finding the suspect guilty of that crime. As previously described, the experimental design is not the same for all countries that employ this forensic technique. Although the details of the methodology in each country differ, within each country there is a strict standard working protocol. In general, the standard is that the "scent trace" given to the canine is that from the crime scene, and the row of odors in the line consists of odors from the suspect and reference individuals. Each is collected for each line-up procedure, and properly cleaned and sterilized after each use.[9] The two major operating systems for the line-up include the tube-retrieving system and the cloth responding system.

In Finland, for example, the tube-retrieving system is used for line-up procedures (Figure 7.3). The testing room is lined up by two long low platforms, each having seven metal tubes locked into the platform. All subjects (suspect plus reference odors) hold the 10-centimeter stainless steel tubes for 2 minutes. All tubes are then stored in glass jars to prevent cross-contamination. An officer in a room outside the testing area then flips a set of dice to come up with a number combination that dictates the order for the line-up. This order allows the officer to know where to place the suspect scent and where to place a reference (control) person's scent. The officer then carefully places the metal tubes (using metal tongs) on the platform. The canine/handler team then enters the testing area, giving the canine a control

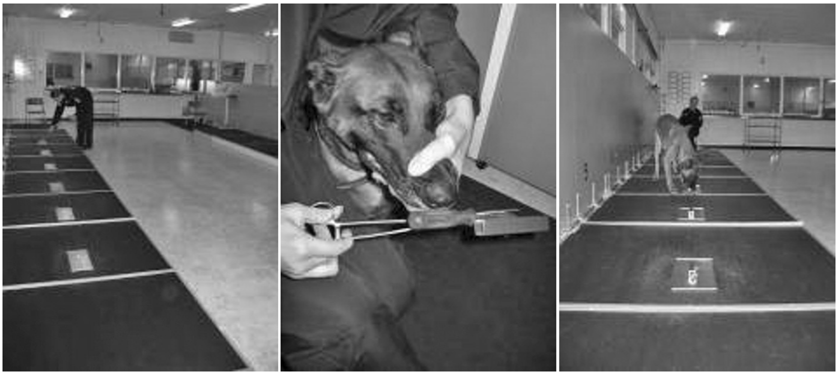

Figure 7.3 Scent identification as conducted in Finland. (Photos courtesy of Ilkka Hormila, Police Dog Training Center, Hämeenlinna, Finland.)

person's object or metal tube, therefore conducting a control check step. The canine is then allowed to go down the platform, with the handler facing away from the dog so as to prevent inadvertent cueing. A green light on the wall in front of the handler indicates to the handler that the dog has made a correct identification. This procedure is repeated with the second platform in the testing room. Only if the dog correctly identifies the control odor in the second line-up row (whether this is a sit, scratch, or bark) is the canine allowed to conduct the suspect identification stage. To start the suspect identification stage, the canine handler team exits the testing area so that the officer in charge can reset the tubes on the platform as needed. The same procedure as that for the control check is conducted for the suspect scent trace, and if the dog responds to the odor of the suspect in both rows, the laboratory can conclude that the scent evidence object and that of the suspect share odor similarity.[13]

In Argentina, instead of employing metal tubes, the scent is presented to the canines via sterile gauze pads inside glass jars, or the cloth-responding system traditionally used in Eastern Europe. The line-up is also conducted in a controlled laboratory testing area, where typically six different jars are aligned on the floor on top of a supporting device, jars being 70 centimeter apart from each other (Figure 7.4). The scent samples are placed on the testing area by personnel not related to the canine, and the same as with the tube-retrieving description above, once the canine team is on the testing

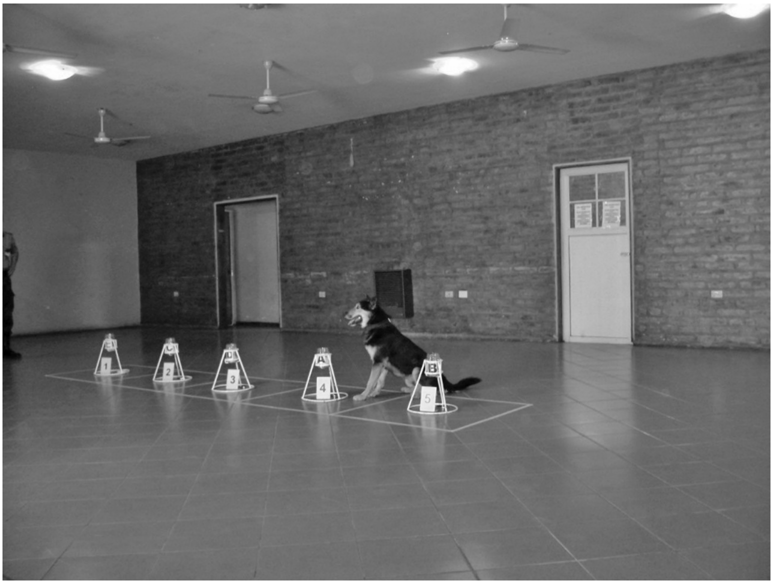

Figure 7.4 Scent identification line-ups as conducted in Argentina. (Photo courtesy of Dr. Mario R. Rosillo.)

area, the handler signals the canine with a "find" command to perform the line-up down the row of scents. Once the canine gives the final response, photographs as well as the official investigation statement is given. The official standard operating procedures for the Argentina National Police human scent line-ups can be found in Appendix A.

SWGDOG provides best practice guidelines for this important scent detection category. Although department or agency procedures have a set of strictly administered protocols, initial handler training recommendations include factors influencing scent identifications, handling, storage and preservation of prescented objects, evidence collection protocols, and proper preparation of line-up scenarios according to agency requirements. For odor recognition assessments, it is recommended to perform four runs on two scent line-ups, called *potential-match runs*. These line-ups are suggested to include odors from 12 different people, and the prescenting of material from four different target subjects. Also, it is recommended that at least four different kinds of articles be used for prescenting purposes. The canine should be able to conduct 75% of the runs successfully. As for the comprehensive assessments, it is recommended to conduct six runs on three line-ups, four of which are potential matches and two of which have nonmatch results, so that the canine can demonstrate the absence of a matching scent association. Proper double-blind assessments are also recommended for proficiency as well as routine maintenance training with a variety of objects, human targets/distractors, and an array of stored scent samples employed for prescenting.[14]

7.1.7 Searching for Live People in Disaster Environments

Not all scent detection capabilities entail the use of dogs for finding criminals in a legal investigation, but rather exploit their keen olfaction capability to save lives. One of the most common uses of human scent dogs is for search and rescue (SAR) missions. Unfortunately, both natural and man-made disasters strike inadvertently and on a regular basis. A crucial factor in reducing the mortality rates in these events is the fast recovery of survivors under rubble of collapsed structures. Historical uses of search and rescue dogs can be traced back to World Wars I and II where canines were used on the battlefield to aid in finding wounded soldiers and carry first aid supplies.[15] Currently, there are over 150 air scenting search dog team units in the United States.[16] Most of these SAR units develop standards and constantly participate in different testing situations in order to validate mission proficiency. In an effort to help set the stage for nationally recognized standards, SWGDOG has facilitated this process by bringing members of the SAR community together to develop best practice guidelines in this discipline, as we will describe further. The Federal Emergency Management Agency (FEMA) is in charge of the national response to disasters. FEMA draws on the cooperation and expertise of the rescue community to enhance their standards of operation to be capable to respond to any disaster. A canine trained for disaster work possesses advanced agility, including moving over unsteady surfaces, climbing up and down ladders and rubble, and entering small, dark, and confined spaces.[17]

From an international perspective, the International Rescue Dog Organisation is the worldwide representative for 115 rescue dog organizations from 39 different countries. It offers training, events, and activities so that rescue canine teams can achieve proficiency levels within this critical scent detection mission.[18] Other valuable assets in this discipline include extensive studies by Spanish investigator Jaime Parejo, who has developed the internationally renowned Arcon method as a unified official system for the formation and intervention of search and rescue canines in Spain and now in numerous other Latin American countries such as Chile, Colombia, Costa Rica, Ecuador, El Salvador, Nicaragua, Mexico, and Venezuela (see Figure 7.5). The Arcon method differs from other established systems by focusing on the visual optimization of three fundamental parameters including autonomy, motivation, and psychological concentration that canines experiment with during the different operations within a search and rescue mission.[19] The method intertwines these three parameters with seven innovative behavior techniques such as support without demand via restricted approximation and progressive autonomy through the "mannequin effect," to name a few.

As per recommended SWGDOG best practice guidelines, initial handler training in disaster work should include topics such as search techniques, use of personal protective equipment (PPE), first aid for canine and subject/victim, pertinent National Incident Management System (NIMS) classes, structural collapse, and hazardous materials awareness. As with other scent detection categories, disaster work canines are recommended to be evaluated via odor

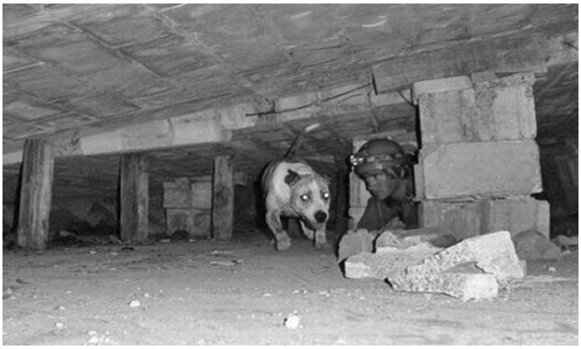

Figure 7.5 Search and rescue training in confined spaces by Jaime Parejo in San Salvador. (Photo courtesy of Jaime Parejo, Arcon Method, Seville, Spain, www.metodoarcon.org.)

recognition, and comprehensive, double-blind assessments. Recommended guidelines for an odor recognition assessment include having a controlled search area with at least five different props (made from materials that control scent), including one blank, two distraction props, and one with a live individual. The distance that is suggested as best practice is approximately 23 meters from the starting point, with no false responses allowed. For a comprehensive assessment, two separate search areas are recommended with a minimum distance of 6 meters, one as a handler limited access site, and the other as a handler full access area. These search areas should have rubble piles resembling collapsed structures, measuring between 600 and 1400 square meters. A range between one to four "victims" should be in the areas, along with distractors such as food, animals, and noise. A successful assessment result should be a 75% positive alert rate, with no false alerts.[20]

7.1.8 Tracking/Trailing People Based on Last Known Position

This area of human scent dog work employs a canine team in the active search of a specific person's track or trail upon the canine being started at the location where the target person (or scented article from that individual) was last seen. The objective of this scent detection category is for the canine to detect and follow the track or trail to the exclusion of other tracks or trails present on the scene. Thus, the canine must identify this specific scent trace leading to the person, location, or article having an association with the target subject. This mission can also be utilized to find other articles left by the target subject along the path it traveled.

It is important to highlight the differences between a tracking and a trailing canine. Tracking canines use both human scent and environmental disturbances to locate the track of the individual, but are not given an individual scent to follow. Tracking dogs follow the trail with their head down and nose on the path, thereby following very closely the footstep-to-footstep track of the individual. As an individual walks in the environment, he/she is constantly changing environmental surface characteristics such as vegetation and insects, which are crushed along the path releasing an odor as a result of these contacts.[21] Practical implications of various studies have determined that canines trained to follow a track do not necessarily learn to determine the track's direction, and footsteps alone provide enough olfactory information to determine directionality (a minimum of five sequential footsteps). Dogs do not determine the direction of a track by following each step from heel to toe thus being able to follow even if the individual walked backward and present no preference of position when approaching a decision point.[22–24] The dog's behavior has been summarized into three distinct phases, which consist of an initial searching phase, a deciding phase, and a final tracking phase. The deciding phase is usually characterized by a slow moving speed and periods of sniffing that are usually longer than the other two phases. Thus, the ability to determine the correct direction seems to rely on methods of sampling air and a specific sensitivity for certain substances.[25]

Trailing canines are given a scent at the beginning of the trail, and if matching scent is present in the environment the canine trails, thus giving the handler a yes/no response in relation to the given scented article. Trailing dogs do not follow footstep to footstep, but rather a combination of ground and air scent. A trailing canine can be said to add scent discrimination to the equation by identifying among other trails the one that matches to the scent article given at the beginning of the trail being searched. In the United States, there are two types of bloodhounds for human scent discrimination purposes, traditional and specialized. Traditional bloodhounds search for matching odor at the start of the trail by pacing back and forth, which is then left up to the handler for interpretation of matching scent or not. Specialized bloodhounds give a yes or no response at the start of the trail by actually trailing if there is a matching scent recognized.[26]

SWGDOG recommended guidelines for this application of scent detection include odor recognition assessments that test the ability of the dog to follow a human track or trail with a minimum of one turn and a distractor track or trail. This odor recognition assessment track or trail should be designed using either a cross-over or split turn track or trail as can be seen in Figure 7.6. These tracks or trails should be within a minimum of 185 meters

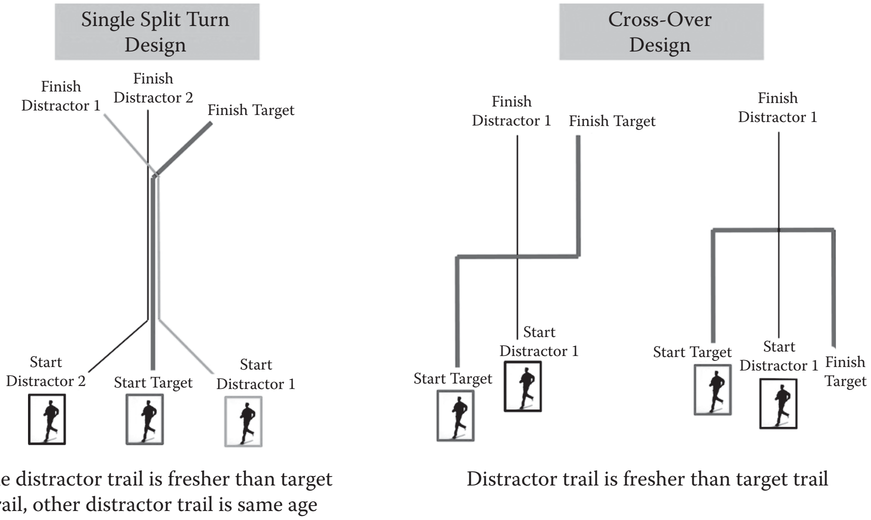
Single Split Turn Design
Finish Distractor 1
Finish Distractor 2
Finish Target
Start Distractor 2
Start Target
Start Distractor 1
One distractor trail is fresher than target trail, other distractor trail is same age
Cross-Over Design
Finish Distractor 1
Finish Target
Start Distractor 1
Start Target
Finish Distractor 1
Start Target
Start Distractor 1
Finish Target
Distractor trail is fresher than target trail

Figure 7.6 **(See Color Insert.)** Schematic of SWGDOG recommended track/trail design for odor recognition assessments in last known position searches. (Data adapted from SWGDOG SC9—Human Scent Dogs Tracking/Trailing People Based on Last Known Position (approved by membership 3/3/2010). Miami, FL: Scientific Working Group on Dog and Orthogonal detector Guidelines.[27])

from each other, of which 90 meters should be track or trail identification. When using the cross-over design, the target track/trail should be aged for a minimum of 1 hour, and the human distractor track or trail a maximum of 30 minutes. Successful assessment results include the ability of the dog to determine the direction of travel beyond the turns to its completion. When performing a comprehensive assessment, parameters should include a rural setting of which the track/trail has a minimum of 730 meters, a minimum of four turns, at least two surface changes, and a minimum of 30 minutes. This assessment should also incorporate an urban setting component of which the track/trail has a minimum of 275 meters, a minimum of three turns, at least two surface changes, and a minimum set time of 30 minutes. The target may also leave personal scented articles along the track/trail. Regular maintenance training as well as double-blind assessments are recommended for proficiency achievement.[27]

7.1.9 Human Remains Detection

Until now, the many applications of human scent presented include tasks such as locating criminals, missing persons, and even survivors after disaster events. However, the use of a human scent canine can sometimes entail the identification of human remains. This type of search dog is useful in many forensic circumstances to locate human cadavers, body fluids, body parts, and even traces of human decomposition in a given location or surface. Although it is not listed as a human scent dog under SWGDOG guidelines, but rather as a substance detection tool, cadaver dogs alert to another type of human scent altogether, the scent of the dead. Rather than discriminating scent traces from specific individuals, cadaver dogs simply alert to the generic scent of *human* (as opposed to other animal) decomposition.

In the United States, the first canine trained for human remains detection by a police department was in 1974 in New York. In 1977, the Connecticut State Police formally instituted a training program for cadaver search canines. The efforts of this program ranged from locating victims above ground as well as buried bodies. Different police departments continue to this day with this effort as well as over 100 independent volunteer cadaver dog teams around the country.[28] The usefulness of human remains detection as a tool in a range of forensic investigations has made different countries exploit the canine nose for this particular purpose. For example, in the United States, Mexico, and other European countries, cadaver dog teams are commonly employed to search for clandestine graves. Countries like Colombia, for instance, embarked in 2005 on the formal development of cadaver dog teams to aid in their quest for the rapid identification of mass graves that are the result of decades of internal warfare conflict (Figure 7.7). The program was launched with five canine teams, three Labradors (Luna,

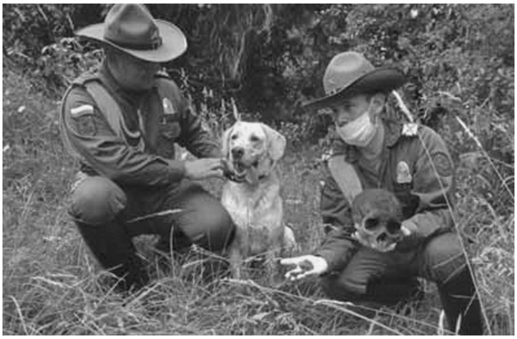

Figure 7.7 (See Color Insert.) Human Remains Canine Team, Colombia National Police. (Photo courtesy of Colonel Mario Chavez.)

Lander, and Chano), and two Belgian Malinois (Kelly and Hasan), deployed on various operational missions throughout the country. The advantage of employing canines for this crucial detection mission is enhanced search area coverage, including dense rainforest terrains.[29]

Even though cadaver scent is not the same as live human scent, the principles of transfer and movement in the environment are the same as those discussed in Chapter 4. This scent can be described as a more general odor and not unique to the specific individual. However, the scent of death undergoes different stages as the level of decomposition progresses from the initial biological time of death to full skeletonization. In general, decomposition is made up of two distinct phases: autolysis, which is the destruction of soft tissues by cellular changes after death and putrefaction, which is the degradation caused by bacteria. Autolysis is the early biochemical changes of the decomposing body. During this stage, all cellular activity ceases and ultimately results in a general tissue necrosis (death). Cell membranes begin to deteriorate and the cell swells. Enzymes begin to consume the cell and decomposition is noticeable by the pale color of the tissues. Autolysis also produces changes common to forensic pathologists such as algor mortis (cooling of the body temperature), livor mortis (blood pooling), and rigor mortis (muscle stiffening). Putrefaction then follows this phase by the production of gases caused by bacteria infestation into the circulatory system causing the blood vessels to blacken. The corpse then begins to bloat, soften, and then eventually liquefy causing all tissues to disintegrate.[30]

Proper training must expose the canine to these different "levels" of decomposition. Materials used for training aids can include both natural and synthetic sources. Natural sources (i.e., actual body parts, fluids, bones), however, present a health hazard for both handler and canine in their use and handling. Sources may include human flesh, blood, adipocere, and skeletonized remains (Figure 7.8). Soil from burial sites can also be used as an effective training aid, as it contains some of the by-products caused by the

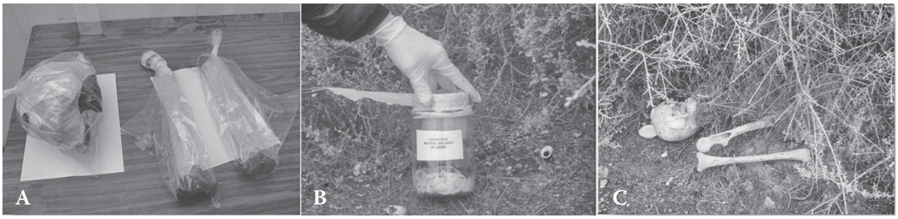

Figure 7.8 **(See Color Insert.)** Training aid materials: (A) gauze wrapped around human bones, (B) putrefied biological material, (C) human bones on actual surface. (Photos courtesy of Dr. Mario R. Rosillo.)

putrefaction process. Objects such as clothing or other articles in contact with the corpse may also be utilized. Synthetic sources can include actual chemical "mimics" such as putrescine or cadaverine, or other commercially available pseudo scents.[27]

Currently there is a demand for improved canine training aids for human remains detection. An area of many research efforts include the identification and understanding of the chemical odor profiles associated with the decomposition of human remains. The actual chemical odor signature(s) that elicit a response from a cadaver dog is not strictly defined, however, several attempts are made to correlate odor profiles with canine responses. A study conducted in 2003 employed 1-5-pentanediamine (cadaverine), 1,4-butanediamine (putrescine), indole, and 3-methyl indole (skatole) as training aids and reported canine alerts when using these pure chemical forms during field testing exercises.[31] Other studies have investigated the reliability and accuracy of canines' responses in simulated burial sites at different depths and stages of decompositions,[32,33] as well as in scent line-up procedures with cadaver scented articles.[34] More recently, the IFRI laboratory employed the use of the Scent Transfer Unit (STU-100) for the creation of potential training aids for cadaver dogs. This methodology used 26 trained human remains detection canine teams, and an array of scent sources, such as gauze pads wiped over a deceased body, adipocere, or simply soaked in decomposition fluid or blood. Overall, the STU-100 based training aids presented great potential yielding a 90% response from the majority of the canines, using different concentrations and employing different sources of target decomposition odor.[35]

Further investigations into the chemical composition of decomposition odor have aided in the determination of the chemical odor profile of this complex biological matrix. Results have shown the release of a multitude of volatile organic compounds from actual human remains (ranging from acids, alcohols, aldehydes, halogens, aromatic hydrocarbons, ketones, and sulfides)[36] and over 400 specific compounds related to burial decomposition as measured from air samples from bodies buried up to a 4-year time span.[37,38]

SWGDOG best practice guidelines recommend human remains detection training on both land and water. For land applications, the canine team should be tested on at least two types of training aid materials, and a minimum of four search areas (with a minimum of one blank area). The search area categories include wilderness, urban, building/structure, and disaster area sites. For successful completion of assessments, a canine team should achieve at least 90% confirmed response rates. For water applications, the search locations and environments should include a variety of types such as shoreline searches, shallow, deep, still and swift water currents, as well as cadaver material at varying depths of water. The recommended placement of the training aids for a shoreline assessment should be no less than 46 meters in length and no more than 4 meters from shore. For a boat assessment in calm water, the aid should be placed no less than in a 90 × 90 meters search area with the area divided in quadrants.[39]

As explored in this chapter, human scent canines are employed in different operational settings, each with a particular objective to maximize the use of the canine team. With each scent detection discipline comes a number of challenges that ultimately influence the direction and efficacy of the search. However, it can be seen that regardless of the application for which the canine is used for, a basic knowledge and understanding of the principles of human scent play a pivotal role in the use and ultimate limitations of the biological detector.

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Future Biometric and Diagnostic Applications

8

8.1 Human Scent beyond the Forensic Arena

> Odors have an altogether peculiar force, in affecting us through association; a force differing essentially from that of objects addressing the touch, the taste, the sight or the hearing.[*]
>
> **—Edgar Allan Poe**

The implementation of human scent in terms of various forensic settings has been discussed, allowing law enforcement personnel to exploit this evidence tool in criminal investigations. In this chapter, however, details of how this novel trace evidence tool can become a potential forensic profiling system and even serve as a medical biomarker source will be highlighted. Not only are these applications advantageous for the crime analyst, but they also present advances for the clinician.

8.1.1 Scent as a Biomarker of Disease

As discussed in Chapter 3, the human skin is a rich source of volatile production that has allowed the chemical elucidation of different compounds through an array of analytical techniques. In turn, these techniques have allowed for a number of studies to focus on the detection of specific volatiles that represent the odor of patients suffering different diseases. As the generation of human odor is directly linked to metabolic processes, the volatiles detected are a good reflection of internal health conditions. Sources for volatile identification have included samples from breath, blood, skin, and urine.[1] These disease specific volatiles can then be directly applied as diagnostic tools (i.e., olfactory biomarkers) essential in therapeutic processes.[2–4]

Canines have been implemented for disease detection in the last decade due to their extraordinary sense of smell offering sensitive detection abilities. In cases of cancer, canines have been trained to discriminate odor samples from healthy and diseased individuals using urine, breath, and even watery stool as scent sources. Odors associated with lung,[5,6] breast,[7] bladder,[8] prostate,[9] and colorectal[10] cancer have been used to exploit dog as biological detector system. Results have shown promising results yielding sensitivity greater than 70% as well as high specificity rates within the sampled populations. These studies have shown that canines could be trained to distinguish patients on the basis of the odor signatures emitted by the different specimens more successfully than would be expected by mere chance. Canines have also been implemented to detect hypoglycaemia in diabetic patients, proving to be successful alarm systems to changes in glucose concentrations by notable changes in behavior.[11] Other studies have even evaluated canines for the detection of seizures, with findings suggesting that some dogs have innate ability to alert and/or respond to epileptic patients.[12] Even though the exact mechanisms by which dogs detect these changes is still largely unknown, the usefulness and potential for disease detection has been clearly demonstrated and is thus an area of current research efforts by scientists worldwide.

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[*] Allan Poe E. (1914) *The Works of Edgar Allan Poe,* Volume 7. New York: Charles Scribner's Sons.

8.1.2 Biometric Potential

Biometrics is used to measure an individual's distinctive characteristics, whether physical or behavioral, in an effort to recognize and correctly identify the identity. Some common physical traits used for biometric measurements include fingerprints, hand/palm geometry, retina, iris, or full-face recognition. Behavioral traits include signature, voice, and even keystroke patterns.[13] Technically, any physical or behavioral trait can be used as a biometric measure as long as it satisfies some basic requirements such as: universality (everyone should possess this), distinctiveness (any two individuals should be different in terms of this trait), permanence (trait should be stable over time), and collectability (trait can be quantitatively measured).[14] This biometric system can be described as a pattern recognition method that obtains the measured data from the individual, extracts the "feature set" from the acquired sample, and compares this information to data sets in a database. Thus, a complete biometric measurement has a verification level (comparing the individual's data set to other samples from same individual) and an identification level (comparing the individual's data set to other individuals, a match/no match step).

In terms of human scent, canines have shown the ability to discriminate and ultimately distinguish individuals based on different scent traces in a range of practical missions as we have covered throughout this book. In Chapter 3, it was shown that through the use of instrumental techniques such as solid-phase microextraction coupled to gas chromatography/mass spectrometry (SPME/GC-MS) and Spearman rank correlations, chemical odor profiles have been successfully distinguished among individuals at >99% rates. This seminal work has clearly demonstrated that through the use of multiple samples from the same individual, a subject's baseline odor can be established and thus used to collect a primary set of compounds, or what we coined as *primary odor*. These primary odor compounds can then be used for discrimination purposes using statistical tools such as Spearman rank correlations to determine match/no match thresholds using the acquired chemical odor profile.[15] The feasibility for the use of human scent as a biometric tool has been achieved, thus providing law enforcement personnel with yet another trait that can be used in a large number of security and civilian applications.

8.1.3 Concluding Remarks

The story of human scent evidence is not nearly completed, and this book has only attempted to provide the latest information and methodology in this fascinating field of study. With so many factors affecting its production, collection, and ultimate use in a criminal investigation, it is clearly a never-ending process that must continue with research, practical field testing, and a continuous interchange of knowledge between all the countries that implement this technique. By carefully analyzing different cases of implementation, improvements can be achieved through reviews of experimental designs, training methods, and documentation records. Many points for the development of human scent evidence remain to be explored, and it is hoped this book serves as the foundational framework to continue in this direction. Hopefully, readers will value this invisible trace evidence that is sometimes largely ignored, but that can provide a link in a complex investigative process. More so, after reading this book, the value of the work of man's best friend, whose wet nose provides an essential tool in saving lives, combating crime, and helping national security by using a physical trait that cannot be seen or touched but is always there will be recognized.

…What do you smell like?

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Appendix A: Argentina Human Scent Evidence Standard Operating Procedures

Human Scent Evidence Standard Operating Procedures (SOP)

The following pages include the standard operating procedures for the methodology employed in the province of Corrientes in Argentina, as per Dr. Mario Rosillo, director of the scent identification laboratory.

General Methodology in Scent ID Laboratory

- The stored samples (glass jars, wide opening, twist-top) are located in the *human scent sample classified archives*—this is located in the Criminalistics Department (Scientific police) and are requested upon judicial order in order to conduct the investigation under a strict chain of custody control.
- The laboratory room is designed with ample space (condition adapted for human scent work), conditioned with proper lighting, ventilation, polarized glass in intermediate doors, and floor markings for positions 1–6 delineated as quadrants on the floor for the location of the jar support system, with a distance of 70 cm between each jar holder.
- The placement of the jars on each holder is made by auxiliary personnel not related to the canines (Criminalistics Cabinet), with the proper personal protective equipment (PPE) to prevent contamination (gloves, whole-body suits, booties, face mask).
- The placement of the scent sample jars within each holder takes place in a perpendicular manner so as to avoid facial raft contamination on top of the jars, which could result in auxiliary odors to the canine. For each canine, a new and sterilized jar set is used.
- The officer in charge of the reward system (rubber ball, diameter 6 cm), is not visible to the canine, and the officer's observation of

the process is made through a polarized glass window, with proper personal protective equipment (PPE).

- After each investigation, the jars are washed with water and sterilized, the holders are also washed with water and biodegradable detergents.
- Judicial regulations:
  - Presence of three major witnesses.
  - Presence of Prosecutor, Defense, and/or petition party.
  - Motion for investigation, with signatures from expert witness, prosecutor, defense, witnesses.
  - Photography and video records on behalf of prosecution.
  - Final official statement, with photographic illustrations.
- Laboratory regulations:
  - Three canine/handler teams per investigation.
  - A jar set (6) of sterilized and letter marked jars, per canine.
  - A set of tweezers per canine.
  - Canine and handler do not witness placement of jars, they are located in a waiting area without visual contact from line-up room.
  - The selection of the jar positions is determined by witnesses, prosecutor, defense and/or petitioner. All information is recorded in official statements.
  - All persons present are located behind polarized windows for procedure observation.
  - There is a specific window designed for photography and video recording.
  - All cellular phones must be turned *off*, and there should be no talking during line-up until final canine response (marking, or no marking), handler returns.
  - The scent samples are opened in presence of witnesses and deposited in line-up jars; example, Jar "A" (control odor); Jar "C" (control odor), Jar "E" (suspect odor).
  - Total jars in line-up = 6.
  - Total number of jar positions = 6; example, Position 1/Jar "C"–Position 6/Jar "A."
  - When the canine marks a position, there will be a "sit" in front of the jar, waiting for the reward, while the handler gives the "stay" order. The act of sitting in front of the jar is a response of the short-term olfactory memory; through a behavioral act such as the sit, the canine evokes the memory through behavior. The reward is made from behind the canine, as a surprise factor at the site where the response is made.
  - The officers who give the reward have no previous contact with the canines.

- Six positions, in relation to the short-term memory, which has an approximate capacity of 15 units, with the average over 50% ends up being 6. Our experience has allowed us to prove that exploration is more firm and secure with six jars for the canine.
- Time for the line-up procedure varies per each canine, between 6 and 8 seconds.
- The scenting of the canine with the base odor (odor from crime scene) is made with the canine in a sitting or standing position, for approximately 1 minute, with two to three breaks. While the canine is being scented, handler gently pets canine, rubbing his chest (tranquilizing effect), and commands dog with “find it.”
- Once the canine marks a position, photographs and video are recorded. The results are recorded in logbooks for each canine, whether it is “positive,” “false positive,” or “no marking.”
- The canines enter the line-up room twice a month, and in training center twice per week, with the remaining days being for light exercises, play, and free exploring.

PAGE 1
Sample of Official Statement—Three Canines

Statement has signature at the end.

Viedma, 04 February 2011

Objective: Official Statement Human Scent Identification

To: Criminalistic Cabinet Chief
Subcrio. Claudio Rodriguez
S______________________D

In my duty to address the Criminalistic Cabinet Chief with the objective to inform about the corresponding human scent identification statement, in reference to the cause of the damaged vehicles, **"Station 30° s/Robbery" Case N° 44536/10**, which is being processed in the Court of Instruction N° 2 of this city, Secretary N° 4.

Date of Investigation: **04 February/2011**

Hour: **18 hrs.**

Judgment elements.

For the above mentioned objectives, the offered elements for judgment are the following belongings:

Base Odor: ***Rifle Cal. 22***

Suspect Odor**: *Leonardo Andres Dominguez San Martin***

Human Control Odors**: Witness 1—Witness 2—Witness 3—Witness 4—Witness 5**

Investigation 1: *Leonardo Andres Dominguez San Martin—Canine "Mateo"*

Line-up Design

E	**D**	**A**	**B**	**C**	**F**	**JARS**
1	**2**	**3**	**4**	**5**	**6**	**POSITIONS**

Investigative Conclusion 1/*Leonardo Andres Dominguez San Martin—Canine "Mateo"*
The canine "Mateo" has identified by olfactory comparison, human raft molecules in position N° 4 – Jar "B" (Leonardo Andres Dominguez San Martin), corresponding to the Base Odor (scent samples from Rifle Cal. 22).

Appendix B: Finnish Regulations for Scent Identification

The following pages include the regulations for the methodology employed in Finland, as per Ilkka Hormila, instructor, Police College of Finland, Police Dog Training Center, Hämeenlinna, Finland.

Summary of the Finnish Regulations

1. Description of Methods

Scent identification: The scent evidence will be collected and stored following official orders. The suspect and minimum of five (5) control persons will give their individual scent sample. The police dog will search the scent contact between comparison of scent samples in the special scent detection room.

Scent sample (*corpus delicti*): An article or transfer sample which is collected at the crime scene. It is collected using the official collection methods. The sample is written down in the official minutes.

Individual scent sample: Suspect and control persons will give their id-scent in sterile stainless steel tubes or cotton.

Control person (A–E): Adult person, who has had no contact to suspect and crime scene, unknown person.

Control person A: One person who is drawn up from the whole group. His scent sample will be used in control test.

Control object: Object given to the control person for his scent and used to scent the dog in control runs.

Suspect: Person who is being suspected of particular crime. In each line-up there may be only one (1) suspect.

Metal pipe: Suspect and control persons deposit their scent in it. All pipes must be identical and it is not allowed to mark them.

Platform: It is used for this type of dog work only. On it, there should be a minimum of six (6) places for control objects, which can be locked in position, with each place being marked with numbers from 1 to 6. We had 1 + 6 = 7.

Sequence of scheme: There are 36 different sequence schemes in which the scent identification line-ups can be presented. It is characterized that the dog should go once over the suspect's object to find control person A. This is the way we can show that the dog is not interested in suspect's odor.

Official statement: After scent identification procedures, a written official statement is prepared. In it, there is one of these three different statements, 1—"The dog found the scent identification," 2—"no scent identification," or 3—"no research results."

2. The Space

In the scent detection facility, there should be appropriate space only reserved for this type of work.

In the search room, there should be two identical platforms, platforms 1 and 2. External persons are not allowed to go in it.

The view from the control room should be clear to the search room. All windows should be covered by mirror glass. You can see out from the room but not in it.

During the test, only the official certified supervisor and the helper of the investigation are allowed to be in the control room.

In the building, there should be service, storage, and office space. There should also be space reserved for dog kennels. The facility should be guarded electronically.

3. Tools and Equipment

All pipes should be 10 cm long and made from stainless steel. Pipes and all glass jars should be washed in facility's washing machines. Pipes should be sterilized for 15 minutes at 134°C.

Pipes should be transferred without hand touching (forceps) into clean glass jars. Jars should close using new twist off.

Filled jars should be stored in dark controlled room. All pipes, glass jars, and cotton used throughout the country will be sent to CSI labs from the unit.

4. Staff and Dogs

Scent id-dog handler can only be an officially approved and trained police officer. When the official line-up test is prepared, the handler and his dog must wait in a place where there is no contact to the search room and other persons. He is not allowed to know the right position of line-up. He is not allowed to meet other persons. He enters the search room with his dog. (Double blind).

Each scent identification police dog should first pass the certifying inspection before it can be used in real cases.

Once a year, each dog should be tested to monitor its level of detection capabilities. The chief inspector of the police dog training center will do it. All dogs will be controlled and monitored during the whole year.

Official administrator of line-up test should be a police officer accepted by the Police Academy.

Administrator will receive, control, and accept the scent samples. He will make a decision on the test.

Administrator makes the draw of line-ups. He will accept or reject the alert of handler/dog. He will give a signal via a light indicator to the handler, green = accept, red = reject.

The helper will make the line-up and takes care of all equipment before the test. After the test, he will clean the room and properly store the scent sample. He is not allowed to meet the handler before and during the test.

5. Scent Sample

Scent sample should be recorded without physical contact and following the official orders. It is allowed to add some sterile pipes and/or cotton to the scent sample.

6. How to Record Control Scent from the Suspect and Control Persons

- Time difference between suspects and control persons can be +/–1 hour.
- Subjects will have the pipes in their hand for about 1 minute, during which they should change pipes from one hand to another hand.
- At the end of this procedure, Control person A will also give his scent to some control articles, for about 2 minutes. Before doing so, subject should take more scent/fat in his hands from neck, head, arms.

7. Preparation of Line-Ups

- In one of the two control line-ups, A1 and A2, the position of suspect X should be located before control person A1 or A2.

8. Documentation

- Administrator should record everything on an official document and save a record in the archives.

9. Research Carried Out

- After the dog has performed positively on the two control A tests, the team goes out from the room to rest the dog for awhile. The handler can decide length of time (5 to 10 min). The target is to get the stress down and get full concentration for the next line-up.

9.1 Control Test

- If dog makes a wrong alert or does not find the correct A, the result is "no research results" and he may not proceed.

9.2 Main Test

- Handler can present the scent sample as much as he likes to the dog.
- He can also give more scent to the dog during the test.
- Handler should give a signal if the dog cannot find the scent from the line-up.
- Handler should sit at the beginning of each line-up. He can sit facing toward or away from the line-up.

9.3 Interrupt and Stop the Test

- Handler can stop the test while the dog is working, if he so deems it appropriate.
- Administrator can also interrupt and stop the test. He should inform the handler.

9.4 Official Statement

An official statement should be written. In it, there should be all information pertaining to the crime, scent sample, and suspect.

In the official statement, there should also be an extra statement that reads:

"The dog found the scent identification" = in the case that the dog alerted to the id-odor of suspect.
"No scent identification" = in the case that the dog signals no odor of suspect or there was too little of suspect's odor.
"No research results" = the test could not be done or it was interrupted.

The official statement should be signed by the official administrator and the canine handler.

10. These Official Guidelines Are Accepted by The Police Board of Finland

The Police Academy will give guidelines for how to collect and store scent samples, also how to take scent samples from suspect and control persons and they can update the guidelines.

Guidelines for Collection and Storage of Scent Samples

1. All Police Officers Are Allowed to Collect Scent Samples at the Crime Scene

Before you start to collect samples, review guidelines.

1.1 At the Crime Scene

- Try to use protection gloves.
- Collect the sample.
- Each sample to its own glass jar or scent/arson sample bag.
- Try to always use glass jar or scent/arson sample bag to avoid contamination.
- Try to collect scent using forceps.
- If using glass jar, remember to close twist off, also close the sample bag carefully.
- Keep a record of all you have done and write it in the report:
  - Who collected sample
  - Where and when
  - How you did perform it
  - Conditions
  - Etc.
- Use id-code number to each sample.
- Send it as soon as possible to the CSI office.

Within these guidelines, there are guidelines for the CSI lab that should be taken into account, when doing the transfer of odor, how to keep samples, what kind of material should be used, and research requests.

Appendix C: SWGDOG SC2—General Guidelines

Posted for public comment 12/16/06–2/16/06. Approved by the membership 4/2/2006.
1st revision—Posted for Public Comment 6/24/09–8/22/09. Approved by the membership 9/15/2009.

Statement of Purpose: To establish consensus-based best practice general guidelines for training, certification, and documentation pertaining to all canine disciplines. Discipline specific guidelines are found within the corresponding subcommittee documents.

1. Initial Training
    - 1.1 The handler training shall be conducted by a competent trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
    - 1.2 The canine training shall be conducted by a competent canine trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
    - 1.3 Initial training shall include sufficient obedience training to ensure the canine will operate effectively based on mission requirements.
    - 1.4 The canine shall be trained to perform an effective and controlled search.
    - 1.5 The initial training of the canine shall include training of a determined specific final response (active or passive alert).
    - 1.6 Initial training shall include exposing the canine team to a variety of locations, expected situations, and searches.
    - 1.7 The training shall be structured to meet the typical mission requirements of the canine team's department/organization.
    - 1.8 The canine team's training shall be continued to achieve a level of operational proficiency until certification evaluation.

2. Canine Team Assessments
    - 2.1 Assessments are part of certification, maintenance training, and proficiency testing.
    - 2.2 Each assessment is the evaluation of a search.
    - 2.3 The canine team shall be assessed in the following ways:
        - 2.3.1 Odor recognition assessment.
            - 2.3.1.1 The handler shall be advised of the parameters of the search.
            - 2.3.1.2 The handler may know the number of target objects, but not the placement.
            - 2.3.1.3 The evaluating official shall know the desired outcome of the search.
        - 2.3.2 Comprehensive assessment (single-blind assessment).
            - 2.3.2.1 The handler shall be advised of the parameters of the search, yet shall not know the desired outcome.
            - 2.3.2.2 The handler shall not know the number or placement of the target objects.
            - 2.3.2.3 The evaluating official shall know the desired outcome of the search.
            - 2.3.2.4 The assessments shall include a blank search.
        - 2.3.3 Double-blind assessment.
            - 2.3.3.1 The handler shall be advised of the parameters of the search.
            - 2.3.3.2 No participant or observer present at the assessment location(s) shall be aware of the desired outcome of the search.
            - 2.3.3.3 The assessments may include a blank search.
    - 2.4 Each assessment will address the following areas:
        - 2. 4.1 Demonstration of the canine's ability to perform a systematic search.
        - 2. 4.2 Demonstration of the handler's control of the canine during the execution of a systematic search.
        - 2. 4.3 Demonstration of the handler's ability to accurately interpret the canine's changes in behaviors associated with odor detection and identification.
        - 2. 4.4 Demonstration of the handler's ability to determine whether or not the canine has made a final response.
        - 2.4.5 In a double-blind assessment it may not be possible to include all of the handler and canine assessment areas listed above.

3. Canine Team Certification
   - 3.1 Certification for the named canine team shall be valid for one year.
     - 3.1.1 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.
     - 3.1.2 The certifying official(s) shall not be routinely involved in the day-to-day training of the canine team being evaluated.
     - 3.1.3 For successful certification, the canine team shall achieve at least a 90% positive alert rate, unless otherwise dictated by the specific discipline, combined with a false alert rate as identified by the subdisciplines (distinct objects search versus continuous area search). Positive and false alerts are defined and calculated as follows:
       - 3.1.3.1 A positive alert is defined as the trained detection alert in the presence of the target odor. The rate is calculated as the number of positive alerts divided by the number of available targets. For example, if the certification has 10 target odors and the canine team identifies nine odors, it will have achieved a 90% positive alert rate.
       - 3.1.3.2 A false alert is defined as an alert in the absence of the target odor. This is determined in one of two ways and shall be defined before the evaluation, depending upon the nature of the detection task involved in the certification (distinct objects search versus continuous area search):
         - 3.1.3.2.1 In subdisciplines in which certification involves searching a defined number of distinct objects (i.e., pieces of luggage, odor recognition cans, scent boxes, parcels, persons, vehicles), the false alert rate is calculated as the number of false alerts divided by the number of nontarget objects, not to exceed 10%. For example, if the certification test involves searching a set of 24 pieces of luggage in which four pieces contain targets and 20 are nontarget objects, and the canine team exhibits one false alert on a nontarget piece of luggage, then the team's false alert rate is calculated as 1/20, or 5%.

        - 3.1.3.2.2 In subdisciplines in which certification primarily involves searching continuous areas (i.e., warehouses, vehicle lots, aircraft, buildings), the number of distinct search objects within the continuous search area is immeasurable. The number of false alerts should not exceed one per continuous searchable area as defined by the specific discipline (refer to SC8 and SC9 documents).
    - 3.1.4 Handler errors, when excessive, may result in failure of the team.
    - 3.1.5 A mission oriented test environment shall be used.
  - 3.2 Certification shall consist of a number of assessments that together form the full test.
    - 3.2.1 Each assessment is the evaluation of a search.
    - 3.2.2 Aids and/or targets used in the day-to-day training activities of the team being certified should not be used in the certification process.
    - 3.2.3 The certification shall be comprised of a comprehensive assessment together with either an odor recognition assessment or a double-blind assessment, or both.
  - 3.3 A canine team that fails the certification process shall complete a corrective action plan before making another attempt to certify.
- 4. Maintenance Training
  - 4.1 The canine team shall conduct regular objective-oriented training sufficient to maintain and enhance operational proficiency. Maintenance training shall include the following:
    - 4.1.1 Correcting identified deficiencies or operational concerns.
    - 4.1.2 A variety of search locations, location sizes, and environmental conditions.
    - 4.1.3 Varied duration of search times.
    - 4.1.4 Varied times of day/night.
    - 4.1.5 A variety of blank searches.
    - 4.1.6 A variety of distractions in the search area.
    - 4.1.7 A variety of set times.
    - 4.1.8 A variety of target odors, amounts, number of targets, and different sources of targets where applicable.
    - 4.1.9 A variety of methods of concealment.
  - 4.2 Training conducted solely by the handler to maintain the canine's proficiency is acceptable, but should be periodically combined with supervised training.

    - 4.2.1 Supervised training, by a qualified trainer/instructor, is recommended in order to monitor and improve performance, identify and correct training deficiencies, and perform proficiency assessments.
  - 4.3 A canine team shall complete a minimum of sixteen (16) hours of training per month to maintain and improve the proficiency level of the team.
  - 4.4 The canine team shall undergo periodic proficiency assessments as outlined in section 2 of the Canine Team Assessments. These assessments should include a variety of odor recognition assessments, comprehensive assessments, and/or double-blind assessments.

5. Record Keeping and Document Management
  - 5.1 The handler/department/organization shall document training, certification, proficiency assessments, and discipline-related deployment data.
    - 5.1.1 Training and proficiency assessment records may be combined or maintained separately.
    - 5.1.2 Discipline-related deployment records shall be maintained separately from training, certification, and proficiency assessment records.
    - 5.1.3 Training and discipline-related records should be standardized within the department/organization.
  - 5.2 Training records may include, but are not limited to, the following data:
    - 5.2.1 Name of handler and canine.
    - 5.2.2 Name(s) of individual(s) conducting/assisting training.
    - 5.2.3 Time and date training took place.
    - 5.2.4 Location and environmental conditions.
    - 5.2.5 Training design (nonblind, single-blind, or double-blind).
    - 5.2.6 Description and number of target(s).
    - 5.2.7 Location of target(s).
    - 5.2.8 Set time.
    - 5.2.9 Size of search area.
    - 5.2.10 Length of session.
    - 5.2.11 Search results.
    - 5.2.12 Deficiencies and corrective measures implemented.
    - 5.2.13 Other information required by department/organization.
  - 5.3 Certification records shall be maintained by the certifying authority and the handler, and include the following information:
    - 5.3.1 Name of canine and handler.
    - 5.3.2 Date team certified.

- 5.3.3 Certification authority, i.e., agency, professional organization, and/or individual(s).
- 5.3.4 The standard or guideline under which the canine team is certified.
- 5.3.5 Name of individual(s) awarding certification.
- 5.3.6 Search area types included in certification assessment.
- 5.3.7 Type and amount of materials included in certification assessment.
- 5.3.8 Location of certification.
- 5.3.9 Set time.

5.4 Proficiency assessment records maintained by the handler/department/organization may include, but are not limited to, the following data:

- 5.4.1 Name of handler and canine.
- 5.4.2 Name(s) of individual(s) conducting assessment.
- 5.4.3 Time and date assessment took place.
- 5.4.4 Location and environmental conditions.
- 5.4.5 Assessment design (single-blind or double-blind).
- 5.4.6 Search area types included in the proficiency assessment.
- 5.4.7 Type(s) and amount(s) of material included in the proficiency assessment.
- 5.4.8 Set time.
- 5.4.9 Size of search area.
- 5.4.10 Proficiency assessment results.
- 5.4.11 Other information required by department/organization.

5.5 Supervisory review of all records is recommended.

5.6 Digital format is recommended to facilitate compiling and analyzing data.

5.7 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by department/organization guidelines.

5.8 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.

5.9 Confirmed operational outcomes can be used as a factor in determining capability.

5.10 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine team's proficiency, i.e., residual odor can be present or concealment may preclude discovery.

5.11 Training aid records
  5.11.1 Training aids shall be clearly labeled in a manner to support accountability.
  5.11.2 Appropriate records shall be maintained by the handler/department/organization in accordance with federal/state/local requirements.
5.12 Veterinary records
  5.12.1 Veterinary records shall be maintained in a manner such as they are accessible to the handler/department/organization.
  5.12.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

Appendix D: SWGDOG SC8—Substance Detector Dogs

Human Remains Detection (HRD)

Land and Water

Posted for public comment 1/14/09–3/14/09. Approved by the membership 9/15/09.

Statement of purpose: To provide recommended best practice guidelines for training, certification, and documentation pertaining to human remains (cadaver) detection canines on land and/or water. The following guidelines pertain to land and water or a combination of both applications.

1. Initial Training
   - 1.1 The canine trainer shall be competent in human remains detection and utilize a structured curriculum with specific training and learning objectives.
   - 1.2 The training course shall include training on the complete spectrum of human remains at varying stages of decomposition. All training aids shall be treated as biohazardous material. The procurement, use, handling, storage, and disposal of training aids shall be in compliance with applicable local, state, and federal requirements. Examples of training aids include the following:
     - 1.2.1 Human blood (fresh and old).
     - 1.2.2 Human decomposition material (tissue, adipocere, wet and dry bones, body fluids).
     - 1.2.3 Burned human tissue.
   - 1.3 The quantity and type of substances used shall be dependent on the region, mission, and operational deployment needs of the canine team.
   - 1.4 Training shall include exposing the canine to a variety of different types of searches, locations, and environments.

- 1.5 The training shall include varying quantities of target odors, containers, and varying lengths of placement time.
- 1.6 The canine shall be trained to perform an effective independent search on or off-lead without excessive handler guidance.
- 1.7 Handler/trainer training shall include the following:
  - 1.7.1 Search planning, techniques, tactics, and equipment.
  - 1.7.2 Dog handling techniques.
  - 1.7.3 First aid for dog and handler.
  - 1.7.4 National Incident Management System (NIMS) (ICS 100 and 200, IS 700) courses are available online.
  - 1.7.5 Additional training as specified by local, state, and federal requirements.
  - 1.7.6 Proper use, handling, storage, and disposal of biohazardous materials.
  - 1.7.7 Legal aspects and courtroom testimony as outlined in Sub Committee 6's document.
  - 1.7.8 Crime scene/evidence preservation/and record keeping.
  - 1.7.9 In addition, water safety shall be included for HRD water teams.
- 1.8 The initial training should continue until the HRD canine team is certified or deemed unacceptable.

2. Certification
   - 2.1 Certification for HRD canines shall be comprised of a comprehensive assessment together with either an odor recognition assessment or a double-blind assessment, or both as outlined in SWGDOG General Guidelines.
     - 2.1.1 Odor recognition assessment
       - 2.1.1.1 The handler shall be advised of the parameters of the search.
       - 2.1.1.2 The handler shall know the number of target objects, but not the placement.
       - 2.1.1.3 The evaluating official shall know the desired outcome of the search.
     - 2.1.2 Comprehensive assessment
       - 2.1.2.1 The handler shall be advised of the parameters of the search, yet shall not know the desired outcome.
       - 2.1.2.2 The handler shall not know the number or placement of the target objects.
       - 2.1.2.3 The evaluating official shall know the desired outcome of the search.
       - 2.1.2.4 The assessments shall include a blank search.

- 2.1.3 Double-blind assessment
  - 2.1.3.1 No participant or observer present at the assessment location(s) shall be aware of the parameters of the search.
- 2.2 Ideally, the certification shall be designed in a manner that resembles searches conducted in the canine team's normal operational environment.
- 2.3 The test shall be designed to evaluate:
  - 2.3.1 The canine's ability to recognize the odor.
  - 2.3.2 The canine's ability to respond to the odor.
  - 2.3.3 The handler's ability to recognize the canine's alert.
  - 2.3.4 The handler's ability to articulate where the material is located.
- 2.4 For successful certification, the canine team shall achieve a 90% confirmed alert rate with no false alerts.
- 2.5 A canine team that fails the certification process shall complete a corrective action plan before making another attempt to certify.

3. Maintenance Training
   - 3.1 Maintenance training is meant to sustain and enhance the performance of the handler, canine, and the canine team.
   - 3.2 In training, situations are purposely sought where the capabilities of the canine and handler are challenged within the operational environments for which the team may be deployed.
   - 3.3 Routine maintenance training is essential in order to maintain mission readiness. A canine team shall spend a minimum of 16 hours per month in routine land and/or water training to maintain the proficiency level of the team.
   - 3.4 The canine team shall conduct regular objective-oriented training sufficient to maintain and enhance operational proficiency. Maintenance training shall include the following:
     - 3.4.1 Routine training, conducted solely by the handler to maintain the canine's proficiency and to reinforce odor recognition, is an acceptable form of training but must be combined with supervised training on a regular basis.
     - 3.4.2 Supervised training, conducted by a competent trainer other than the handler, in order to improve performance, identify and correct training deficiencies, and perform proficiency assessments is considered a best practice.
4. Training Aids
   - 4.1 Training shall be done on actual human remains in varying stages of decomposition to conform to best practices.
     - 4.1.1 The source of the training aids shall be reliable and documented.

- 4.2 The training aids shall be labeled and packaged in a manner safe for both the handler and canine throughout training.
  - 4.2.1 Each label shall contain, at minimum, the type of training aid, a biohazard label, and the date the training aid was acquired.
- 4.3 Each training aid shall be properly stored (either frozen, air dried, or refrigerated) and secured in a safe manner.
- 4.4 Each training aid shall be maintained in a manner to avoid loss, destruction, and cross-contamination.
- 4.5 Handling and care of training aids shall include the following:
  - 4.5.1 Each training aid shall be handled in accordance with biohazard safety standards for proper handling, storage, and disposal.
  - 4.5.2 Each training aid shall be rotated on a regular basis, evaluated to determine the level of decomposition, and replaced if contaminated.
  - 4.5.3 Storage of training aids shall be in a manner that prevents odor and physical contamination, i.e., each range of decomposing cadaver materials should be stored in separate containers.
- 4.6 Disposal and or destruction of the training aids shall follow local, state, or federal guidelines pertaining to biohazardous materials.

5. Records and Document Management
   - 5.1 The handler/organization/agency shall maintain training, and/or deployment/utilization records. Documents shall be retained in accordance with federal, state, and unit guidelines. Records may include but are not limited to the following data:
     - 5.1.1 Training records shall include:
       - 5.1.1.1 Name of handler and canine.
       - 5.1.1.2 Date and time training was conducted.
       - 5.1.1.3 The trainer's name and position.
       - 5.1.1.4 Type and amount of training aid used.
       - 5.1.1.5 Height and/or depth of the hide.
       - 5.1.1.6 Location where training took place.
       - 5.1.1.7 Type of training (wilderness, disaster, land, water, buried, etc.).
       - 5.1.1.8 The training objective (to frame the result of the training scenario).
       - 5.1.1.9 Additional information may include: weather conditions, terrain.
       - 5.1.1.10 Other information as required by the organization and/or agency.
       - 5.1.1.11 Set time.

- 5.1.2 Deployment and utilization records shall include:
  - 5.1.2.1 Name of handler and canine.
  - 5.1.2.2 Date and time of deployment.
  - 5.1.2.3 Location of deployment.
  - 5.1.2.4 Requesting agency.
  - 5.1.2.5 Length of search.
  - 5.1.2.6 Description of search.
  - 5.1.2.7 Type of search (wilderness, disaster, water, etc.).
  - 5.1.2.8 Results of search.
  - 5.1.2.9 Location of a positive find, using GPS coordinates (when available).
  - 5.1.2.10 Other information as required by the organization and/or agency.
- 5.1.3 Certification records
  - 5.1.3.1 Name of canine and handler.
  - 5.1.3.2 Date team certified.
  - 5.1.3.3 Certification authority, i.e., agency, professional organization, and/or individual(s).
  - 5.1.3.4 The standard or guideline under which the canine team is certified.
  - 5.1.3.5 Name of individual(s) awarding certification.
  - 5.1.3.6 Search area types included in certification assessment.
  - 5.1.3.7 Type and amount of materials included in certification assessment.
  - 5.1.3.8 Location of certification.
  - 5.1.3.9 Set time.

6. Use of Records and Documentation
   - 6.1 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by department/organization guidelines.
   - 6.2 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
   - 6.3 Confirmed operational outcomes can be used as a factor in determining capability.
   - 6.4 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine team's proficiency (i.e., residual odor can be present or concealment may preclude discovery).

Land Applications

7. *Initial HRD detection training on land* shall include exposing the canine to a variety of different types of search locations and environments including the following variables:
   7.1 Ground surface.
   7.2 Elevated position not to exceed 2 meters (≈6 ft).
   7.3 Buried at least 15 to 61 centimeters (6 to 24 inches) depending on soil composition.
8. Canine Team Certification
   8.1 Parameters of the test: The test area shall not be an area that is normally used for daily or routine training of the canine team.
      8.1.1 Prior to the start of the certification, the handler will inform the evaluator how the canine will respond when the target odor is detected.
      8.1.2 The human remains detector canine shall be tested on at least two of the suggested materials in the complete spectrum of materials as identified in Sections 1.2.1 and 1.2.2.
      8.1.3 Recommended minimum quantities of materials for certification shall be set in accordance with mission requirements.
      8.1.4 Placement of the aids shall include the following:
         8.1.4.1 Ground surface.
         8.1.4.2 Elevated position not to exceed 2 meters (≈6 ft).
         8.1.4.3 Buried 15 to 61 centimeters (6 to 24 inches) depending on soil composition.
      8.1.5 The test shall include blank areas containing freshly disturbed soil uncontaminated by human remains.
      8.1.6 Animal remains distractors shall be included in at least one search area.
      8.1.7 The certification shall include scenarios resembling searches within the normal operational environment. The test shall include at least four individual search areas with a minimum of one blank area, from at least two of the categories listed below. Individual search areas may contain multiple target odors. The test shall be designed to evaluate the canine's ability to recognize the odor, respond to the odor, and the handler's ability to interpret this alert. Search categories and suggested maximum search times utilized in certifications are listed below:
         8.1.7.1 Wilderness searches shall cover a minimum of 4050 m^2 (≈1 acre) in 30 minutes/acre depending on the scent quantity and source.

8.1.7.2 Urban searches shall cover a minimum of 4050 m^2 (≈1 acre) in 30 minutes. The area searched and search time may vary depending on the scent quantity and source.

8.1.7.3 Building/structure searches shall cover a minimum 93 m^2 (≈1000 sq. ft.) in 30 minutes. The area searched and search time may vary depending on the scent quantity and source. Vehicle searches (interior and exterior) shall cover a minimum of three to six vehicles. Search time should be 3 minutes per vehicle.

8.1.7.4 Disaster area search time may be dictated by the difficulty of the scenario.

8.1.8 The minimum set time of training aids shall be no less than 30 minutes and no more than 24 hours. The maximum set time may be extended as dictated by the mission of the agency.

8.1.9 For successful certification, the canine team shall achieve at least a 90% confirmed alert rate for certification, with no false alerts.

8.2 Use of distractors

8.2.1 Natural distractors are normally present and vary depending on the certification area.

8.2.2 Care must be taken not to place artificial distractions in a manner that causes contamination with the test substance odor. Target odors should not be placed near areas with decomposed human waste.

9. Maintenance Training for HRD—Land Shall Include the Following Components:

9.1 A variety of locations, environmental conditions, and times of day.

9.2 A variety of training aid amounts and the full spectrum of decomposition of those training aids.

9.3 A variety of heights, depths, containers, and distraction odors.

9.4 A variety of types of searches including wilderness, disaster, vehicles, buildings, open areas, and shoreline (based on mission specific requirements).

9.5 A varied duration of search times.

9.6 A variety of search area sizes.

9.7 A variety of blank searches.

9.8 A variety of searches that include animal distractors.

Water Applications

10. *Initial HRD training on water* shall include exposing the canine to a variety of different types of search locations and environments including the following variables:
    10.1 Shoreline searches.
    10.2 Shallow, deep, still, and swift running water from a watercraft.
    10.3 Cadaver material at varying depths of water.
    10.4 Blank areas which do not include human remains but may include animal remains.
    10.5 Empty unused training aid containers.
    10.6 Varying quantities of target odors, containers, and lengths of time of placement.
11. Canine Team Certification
    11.1 Parameters of the test: The test area shall not be an area that is normally used for daily or routine training of the canine team.
        11.1.1 Prior to testing on water, the canine team shall successfully perform an odor recognition test on land.
        11.1.2 Proofing/verification of the certification area should be conducted prior to the actual certification using a certified canine team who is not participating in the certification. This practice is designed to show that the trained odor is present in the target locations and nowhere else.
        11.1.3 Prior to the start of the certification, the handler will articulate to the evaluator the canine's alert to the target odor.
        11.1.4 Handlers are required to wear personal flotation devices (PFDs) when on a boat, pier, or near the water. PFD is optional for the canine.
        11.1.5 The human remains detector canine shall be tested on at least two of the suggested materials in the complete spectrum of materials as identified in Sections 1.2.1 and 1.2.2.
        11.1.6 Recommended quantities of materials for certification shall be no less than 30 grams (1 oz.).
        11.1.7 Placement of the aids shall include all of the following:
            11.1.7.1 Shoreline assessment no less than 46 meters (50 yd.) in length, no more than 4 meters (≈12 ft.) from shore, no greater than 1 meter (≈3 ft.) in depth and spending no longer than 15 minutes to search the area.
            11.1.7.2 Boat assessment: in calm water (lake or pond) no less than 90 × 90 meters (≈100 by 100 yd.) assessment area with the area divided into four

quadrants. Scent material shall be placed in a depth of between 3.0 to 3.5 meters (≈10 to 11 ft.) in one of the quadrants. The canine's response shall be within a radius of 2 meters (≈6 ft.) of the highest concentration of the target odor. Search time in the boat shall be no more than 45 minutes per 90 meter^2 area.

    11.1.7.3 The training aids shall be placed no less than 30 minutes prior to testing.
    11.1.7.4 All training aids shall be removed at completion of certification.
  11.1.8 Ideally, the test shall be designed in a manner to resemble searches within the normal operational environment.
  11.1.9 The test shall be designed to evaluate:
    11.1.9.1 The canine's ability to recognize the odor.
    11.1.9.2 The canine's ability to respond to the odor.
    11.1.9.3 The handler's ability to interpret the canine's alert.
    11.1.9.4 The handler's ability to articulate where the submerged material is located.
  11.1.10 For successful certification, the canine team shall achieve a 90% confirmed alert rate and no false alerts.

12. Maintenance Training for HRD—Water Shall Include:
  12.1 A variety of locations, environmental conditions, and times of day.
  12.2 A variety of training aid amounts and the full spectrum of decomposition.
  12.3 A variety of depths, containers, and distraction odors.
  12.4 A variety of types of searches to include all types of water (still, slow-moving, and fast-flowing water).
  12.5 A varied duration of search times.
  12.6 A variety of search area sizes.
  12.7 A variety of blank searches.
  12.8 A variety of searches that include animal distractors.

Appendix E: SWGDOG SC9—Human Scent Dogs

The following pages include the SWGDOG guidelines for the different areas/disciplines of human scent detection.

SWGDOG SC9—Human Scent Dogs

Article Search

Posted for public comment 1/3/07–3/3/07. Approved by the membership 3/12/07.
Posted for public comment 5/24/10–7/22/10. Approved by membership 9/15/10.

Article Search is the canine scent detection discipline used to search areas, usually near crime scenes, for human-scented articles that were thrown away or inadvertently left behind.

Statement of purpose: To provide recommended guidelines for training, certification, and documentation pertaining to canines and handlers trained for article search.

1. Initial Training
    - 1.1 The handler training shall be conducted by a competent trainer from an entity that utilizes a structured curriculum with specific training and learning objectives. The handler's training shall include the following topics:
        - 1.1.1 Search techniques, tactics, and equipment.
        - 1.1.2 Environmental conditions affecting scent dispersion in order to maximize the canine team's search efficiency.
        - 1.1.3 Proper handling, storage, and disposition of articles as required by the agency/organization.
        - 1.1.4 Techniques for collecting articles considered crime scene evidence as required by the agency or organization.

1.2 The canine training shall be conducted by a competent trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
1.3 Initial canine training shall include sufficient obedience training to ensure the canine will operate effectively based on mission requirements.
1.4 The canine shall be trained to perform an effective and controlled search.
1.5 The initial training of the canine shall include training of a determined specific alert.
1.6 Initial training shall include using articles typically expected in an operational search, such as handguns, tools, credit cards, matchbooks, gloves, ammunition casings, car keys, et cetera.
1.7 Initial training shall include exposing the canine to a variety of different types of locations and environments.
1.8 The training shall be structured to meet the typical mission requirements of the canine team's department/organization.
1.9 The canine team's training shall be continued until a level of operational proficiency is achieved and the team is certified.

2. Canine Team Assessments
    2.1 Assessments are part of certification, maintenance training, and proficiency testing.
    2.2 Each assessment is the evaluation of a search.
    2.3 The canine team shall be assessed in the following ways:
        2.3.1 Scent recognition assessments that test the ability of the canine to indicate human-scented articles, the handler's interpretation of the canine's behavior, the canine's response, and the handler's interpretation of the canine's alert. These assessments shall adhere to the following procedures:
            2.3.1.1 One to three individuals shall be utilized to place human scent on articles which are then thrown into a search area that is typical of the areas where the canine works (e.g., urban/suburban/rural).
            2.3.1.2 The articles shall be held in a closed hand(s) for a minimum of 30 seconds prior to being thrown into the search area.
            2.3.1.3 A minimum of four scent articles shall be thrown into an area that is at least 150 m^2 (≈1600 sq. ft.).
            2.3.1.4 Neither the handler nor canine shall observe the placement of the human-scented articles.
            2.3.1.5 Neither the scent contributor nor the handler shall enter the search area at any time.

2.3.1.6 The set time shall be appropriate to the time the article was in human contact and shall be determined by the testing agency.

2.3.1.7 The search time shall be appropriate to the search area size, the number of articles in the search area, and should impose pressure on the search team.

2.3.1.8 The human-scented articles shall not be visible to the canine or the handler, either before or during placement of the articles.

2.3.1.9 The handler shall be informed of the search area parameters.

2.3.1.10 The handler shall inform the assessor of the canine's trained response (active or passive alert) prior to the test.

2.3.1.11 The assessor shall know the correct outcome of the search.

2.3.1.12 The handler shall know the number of articles placed in the search area.

2.3.1.13 The canine must be able to locate at least 75% of the articles either through a trained active or passive alert that the handler must discern and communicate to the assessor.

2.3.1.14 Responding to articles that were not introduced into the search area for assessment purposes will not be considered a failure. Such responses are not considered correct positive alerts, but are also not considered false positives since it is currently impossible to determine the absence of human scent on articles.

2.3.2 Comprehensive assessments that test the ability of the canine to indicate human-scented articles, the handler's interpretation of the canine's behavior, the canine's response, the handler's interpretation of the canine's alert, and the handler's ability to conclude the search (nothing left to find). Comprehensive assessments shall adhere to the following guidelines:

2.3.2.1 One to three individuals shall be utilized to place human-scented articles within a search area representative of that where the canine team typically works (e.g., urban/suburban/rural).

2.3.2.2 The articles shall be held in a closed hand(s) for a minimum of 30 seconds prior to being thrown into the search area.

2.3.2.3 A minimum of four and maximum of six human-scented articles will be thrown into an area of at least 150 m^2 (≈ 1600 sq. ft.).

2.3.2.4 Neither the handler nor canine shall observe the placement of the human-scented articles.

2.3.2.5 Neither the scent contributor nor handler shall enter the search area at any time.

2.3.2.6 The set time shall be appropriate to the time the article was in human contact and shall be determined by the testing agency.

2.3.2.7 The search time shall be appropriate to the search area size and the number of articles in the search area and should impose pressure on the search team.

2.3.2.8 The articles shall not be visible to the canine or the handler either before or during their placement.

2.3.2.9 The handler shall be informed of the search area parameters.

2.3.2.10 The handler shall inform the assessor of the canine's trained response (active or passive alert) prior to the test.

2.3.2.11 The assessor shall know the correct outcome of the search.

2.3.2.12 The handler shall not know the number of human-scented articles in the search.

2.3.2.13 The canine must be able to locate at least 75% of the human-scented articles and give a trained active or passive alert, which the handler must discern. The handler must communicate the canine's trained alert to the assessor prior to the start of the assessment.

2.3.2.14 Responding to articles that were not introduced into the search area for assessment purposes will not be considered a failure. Such responses are not considered correct positive alerts, but are also not considered false positives since it is currently impossible to determine the absence of human scent on such articles.

2.3.3 Double-blind assessments are those in which neither the handler nor the assessor know the correct outcome of the test. These assessments demonstrate the proficiency of the canine team in an operational setting and shall adhere to these procedures:

2.3.3.1 The search area shall be prepared in an area that is representative of the environment in which the canine handler team usually works.

2.3.3.2 The size of the search area shall depend on operational requirements.

2.3.3.3 Neither the handler nor canine shall observe the placement of the human-scented articles.

2.3.3.4 The area shall be prepared to represent an operational setting. Human-scented articles shall not be visible to the canine, the handler, or the assessor.

2.3.3.5 The set time and search time shall be determined by the size of the area to be searched and operational requirements.

2.3.3.6 The handler and the assessor shall be informed of the search location, but shall not be given further information.

2.3.3.7 Neither the canine handler, nor the assessor, nor any individual present shall know the correct outcome of any portion of assessment.

2.3.3.8 The handler shall inform the assessor of the canine's trained alert prior to the test.

2.3.3.9 The assessor shall observe the canine team and compare the search results with the parameters of the search at the conclusion of the assessment. This may be done immediately after the handler concludes his canine has completed its trained response, or after the conclusion of the whole assessment.

3. Canine Team Certification

3.1 Certification for the named canine team shall be valid for one year.

3.1.1 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.

3.1.2 The certifying official(s) shall not be routinely involved in the day-to-day training of the canine team being evaluated.

3.1.3 Handler errors, when excessive, may result in failure of the team.

3.1.4 A mission-oriented test environment shall be used.

3.2 Certification shall minimally be comprised of a comprehensive assessment. An odor recognition assessment, a double-blind assessment, or both may be added for certification.
  3.2.1 Target articles used in the certification process should not have been used in the day-to-day training activities of the team being certified, and should be "new," so they will not have any dog odor on them from previous tests.
3.3 A canine team that fails to complete the certification process shall complete a corrective action plan before making another attempt to certify.

4. Maintenance Training
  4.1 The canine team shall conduct regular objective-oriented training sufficient to maintain and enhance operational proficiency. Maintenance training shall include the following:
    4.1.1 Correcting identified deficiencies or operational concerns.
    4.1.2 A variety of search locations, location sizes, and environmental conditions.
    4.1.3 Varied duration of search times.
    4.1.4 Varied times of day and night.
    4.1.5 A variety of blank searches.
    4.1.6 A variety of distractions in the search area.
    4.1.7 A variety of set times.
    4.1.8 A variety of article shapes, sizes, manner, and duration of contact, weights, materials, etc.
    4.1.9 A variety of degrees of concealment.
  4.2 Training conducted solely by the handler to maintain the canine's proficiency is acceptable, but should be periodically combined with supervised training.
    4.2.1 Supervised training, by a qualified trainer/instructor, is recommended in order to monitor and improve performance, identify, and correct training deficiencies, and perform proficiency assessments.
  4.3 Article search training shall be included within the minimum of sixteen (16) hours of training per month to maintain and improve the proficiency level of the team.
  4.4 The canine team shall undergo periodic proficiency assessments as outlined in Section 2—the "Canine Team Assessments." These assessments should include a variety of scent recognition assessments, comprehensive assessments, and/or double-blind assessments.

5. Record Keeping and Document Management
    5.1 The handler, department, or organization shall document training, certification, and proficiency assessments and discipline-related deployment data.
        5.1.1 Training and proficiency assessment records may be combined or maintained separately.
        5.1.2 Discipline-related deployment records shall be maintained separately from training, certification, and proficiency assessment records.
        5.1.3 Training and discipline-related records should be standardized within the department or organization.
    5.2 Training records may include, but are not limited to, the following data:
        5.2.1 Name of handler and canine.
        5.2.2 Names of individuals conducting or assisting in training.
        5.2.3 Time and date training took place.
        5.2.4 Location and environmental conditions.
        5.2.5 Training design (nonblind, single-blind, or double-blind).
        5.2.6 Description and number of articles.
        5.2.7 Set time.
        5.2.8 Size of search area.
        5.2.9 Length of session.
        5.2.10 Search results.
        5.2.11 Deficiencies and corrective measures implemented.
        5.2.12 Other information required by the team's department or organization.
    5.3 Certification records shall be maintained by the certifying authority and the handler, and include the following information:
        5.3.1 Name of canine and handler.
        5.3.2 Date team certified.
        5.3.3 Certification authority, that is, agency, professional organization, or individual(s).
        5.3.4 The standard or guideline under which the canine team is certified.
        5.3.5 Name of individual(s) awarding certification.
        5.3.6 Search area types included in certification assessment.
        5.3.7 Type and number of articles included in certification assessment.
        5.3.8 Location of certification.
        5.3.9 Set time.

5.4 Proficiency assessment records maintained by the handler, department, or organization may include, but are not limited to, the following data:
  5.4.1 Name of handler and canine.
  5.4.2 Name(s) of individual(s) conducting assessment.
  5.4.3 Time and date assessment took place.
  5.4.4 Location and environmental conditions.
  5.4.5 Assessment design (single-blind or double-blind).
  5.4.6 Search area types included in the proficiency assessment.
  5.4.7 Type(s) and number of articles included in the proficiency assessment.
  5.4.8 Set time.
  5.4.9 Size of search area.
  5.4.10 Proficiency assessment results.
  5.4.11 Other information required by the team's department or organization.
5.5 Supervisory review of all records is recommended.
5.6 Digitally formatted records are recommended to facilitate compiling and analyzing data.
5.7 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by departmental or organizational guidelines.
5.8 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
5.9 Confirmed operational outcomes can be used as a factor in determining capability.
5.10 Veterinary records.
  5.10.1 Veterinary records shall be maintained in a manner such as they are accessible to the handler, and department, or organization.
  5.10.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

SWGDOG SC9—Human Scent Dogs

Prescented Canine—Aged Trail Search

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Prescented canine aged trail searches use a canine team to search for and follow aged trails of a specific person's (target) scent over different surface types. Prior to the start of the search, the canine is "scented" on an object (scent article) containing the target's scent. The canine works from an article to either a person or a location associated with that person. The goal is for the canine to detect and use a specific person's scent on a scent article to either search for and follow a matching scent trail to this specific person or a location associated with this person while discriminating from all nonmatching scent trails, or to correctly demonstrate the absence of a matching scent trail. Canines used in this discipline are typically deployed in search and rescue and forensic investigative functions, and typically not in immediate apprehension functions.

Statement of purpose: To provide recommended guidelines for training, certification, and documentation pertaining to pre-scented canines.

1. Initial Training
   - 1.1 The handler training shall be conducted by a competent trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
   - 1.2 The canine training shall be conducted by a competent canine trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
   - 1.3 Initial training shall include sufficient obedience training to ensure the canine will operate effectively based on mission requirements.
   - 1.4 The canine shall be trained to perform an effective and controlled search.
   - 1.5 The initial training of the canine shall include training of a determined specific final response (an active or passive alert).
   - 1.6 Initial training shall include exposing the canine team to a variety of locations, expected situations, and searches.
   - 1.7 The training shall be structured to meet the typical mission requirements of the canine team's department or organization.
   - 1.8 The canine team's training shall be continued to achieve a level of operational proficiency until certification evaluation.
   - 1.9 Training shall progressively include scent articles, aged scent, trail distances, locations, and environmental conditions typically expected in an operational search.
   - 1.10 Handler training shall include techniques for collecting human scent evidence.
   - 1.11 Handler training shall include human scent behavior, relevant canine case law, and legal preparation, including court testimony.

2. Canine Team Assessments
   - 2.1 Assessments are part of certification, maintenance training, and proficiency testing.
   - 2.2 Each assessment is the evaluation of a search.
   - 2.3 The canine team shall be assessed in the following ways:
     - 2.3.1 Scent recognition assessments that evaluate the following skills:
       - 2.3.1.1 The ability of the canine to detect and use a specific person's scent on a scent article to follow the matching scent trail to this specific person while discriminating from nonmatching scent trails. The ability of the canine to demonstrate the absence of a matching scent trail.
       - 2.3.1.2 The canine's alert.
       - 2.3.1.3 The handler's interpretation of the canine's alert.
     - 2.3.2 The scent recognition assessment shall consist of four individual assessments with the following components and parameters:
       - 2.3.2.1 For each scent recognition assessment, one human target and two human distractors are utilized to lay human scent trails in an environment similar to where the canine usually works (e.g., urban, suburban, or rural environment).
       - 2.3.2.2 Each scent recognition assessment shall be between 90–183 m (≈100–200 yd.) in length with a single split turn[*] involving one human target and two human distractors.
       - 2.3.2.3 The target trail and one human distractor trail shall be aged a minimum of 1 hour, and one distractor trail shall be aged a maximum of 30 minutes.
       - 2.3.2.4 Prior to the assessment, the start of the scent trail shall be marked by the assessing agency.
       - 2.3.2.5 The handler shall be directed to the start marker, but not given the target's direction of travel.
       - 2.3.2.6 The handler shall be provided a scent article from the target or a nonmatching scent article as a negative control.

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[*] Diagram single split turn: S is starting point human target, F is finishing point.

- 2.3.2.7 The handler shall specify the type of scent article his or her canine used in training sessions prior to the assessment.
- 2.3.2.8 At least half, but not all of the scent recognition assessments shall be conducted with nonmatching scents to demonstrate the absence of a matching scent trail.
- 2.3.2.9 The order of the matching and nonmatching scent recognition assessments shall be randomized.
- 2.3.2.10 The assessor shall know the correct outcome of each assessment.
- 2.3.2.11 The handler shall not know the correct outcome of any assessment.
- 2.3.2.12 A successful completion of the scent recognition assessment is the ability to find the correct direction of travel and follow the scent trail beyond the turn or to correctly demonstrate the absence of a matching scent trail.
- 2.3.2.13 The assessor may take into consideration the environmental influences on the scent in determining whether or not the canine team has successfully completed the scent recognition assessment.
- 2.3.2.14 The canine team shall properly scent discriminate in at least 75% of the assessments.

2.3.3 Comprehensive assessments test the following canine team skills:

- 2.3.3.1 The ability of the canine team to follow a specific person's scent trail along surface types appropriate to the canine team's operational requirements and to identify a specific person or location at the conclusion of the assessment.
- 2.3.3.2 The handler's interpretation of the canine's behavior.
- 2.3.3.3 The canine's response.
- 2.3.3.4 The handler's interpretation of the canine's response.

2.3.4 Comprehensive assessments shall incorporate the following components and parameters:

- 2.3.4.1 One or more different potential target trails shall be approximately 1.6 km (≈ 1 mile) in length in an environment similar to where the canine usually works.

2.3.4.2 Each target trail shall be aged in accordance with mission requirements for a minimum of 12 hours.

2.3.4.3 Each target trail shall contain a minimum of 10 turns.

2.3.4.4 Multiple human distractors, either placed or regularly occurring in the assessment area, shall be present along the distance of the target trail.

2.3.4.5 The assessment location shall be unfamiliar to the handler.

2.3.4.6 The targets and distractors shall not be ones normally utilized in the training of the canine team.

2.3.4.7 The handler shall be informed of the start location.

2.3.4.8 The handler shall be provided a scent article from the target.

2.3.4.9 The handler shall specify the type of scent article prior to the assessment.

2.3.4.10 The assessment should be completed in less than 60 minutes.

2.3.4.11 The assessor shall know the correct layout of each assessment.

2.3.4.12 The handler shall not know the correct layout of each assessment.

2.3.4.13 The handler shall articulate the canine's final response prior to the start of the assessment.

2.3.4.14 The canine shall demonstrate an alert, which should include the final response. This must be communicated by the handler to the assessor.

2.3.4.15 A successful conclusion of the assessment shall be defined by the certifying agency.

2.3.4.16 The canine team shall be required to successfully complete the assessment.

2.3.4.17 Any team that is determined by the assessor to be more than 46 m (≈50 yd.) off the target's trail may be failed. However, the assessor may take into consideration environmental influences on the scent in determining whether or not a canine team is still on trail.

2.3.4.18 Identifying a human distractor shall be considered a failure.

- 2.3.5 Double-blind assessment
  - 2.3.5.1 The double-blind assessment may only be used to fulfill a handler's operational certification if it meets or exceeds the standards in the comprehensive assessment.
  - 2.3.5.2 Any double-blind assessment may be used for proficiency testing.
  - 2.3.5.3 This assessment demonstrates the proficiency of the canine team in an operational setting.
  - 2.3.5.4 The handler will be advised of the start location.
  - 2.3.5.5 The handler shall not know the location of the end point, nor the number of turns to be conducted.
  - 2.3.5.6 The canine team shall be required to successfully complete the assessment as defined by the certifying agency.
  - 2.3.5.7 The handler shall articulate the canine's final response prior to the start of the assessment.
  - 2.3.5.8 Identifying a human distractor will be considered a failure.
  - 2.3.5.9 No individual present, including the handler and assessor, shall know the correct outcome of any portion of the assessment.
  - 2.3.5.10 The assessment may or may not be timed.
  - 2.3.5.11 The assessor, if present, shall observe the canine team. At the conclusion of the assessment, the assessor shall compare the search results with the parameters of the search. This comparison may be done immediately after the handler determines the canine has made its trained response, or at the conclusion of the entire assessment.

3. Canine Team Certification
   - 3.1 Certification for the named canine team shall be valid for one year.
   - 3.2 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.
   - 3.3 The certifying official(s) shall not be routinely involved in the day-to-day training of the canine team being evaluated.
   - 3.4 Handler errors, when excessive, may result in failure of the team.
   - 3.5 A mission-oriented test environment shall be used.
   - 3.6 Certification shall consist of a number of assessments that together form the full test.

- 3.7 Each assessment is the evaluation of a search.
- 3.8 Targets used in the certification process shall not have been used in the day-to-day training activities of the team being certified.
- 3.9 The certification shall be comprised of a scent recognition assessment together with either a comprehensive assessment or a double-blind assessment, or both.
- 3.10 A canine team which fails the certification process shall complete a corrective action plan before making another attempt to certify.
- 3.11 Any competent individual or entity may enhance the recommended SWGDOG guidelines in order to make the requirements more stringent.

4. Maintenance Training
   - 4.1 The canine team shall conduct regular objective-oriented training that includes:
     - 4.1.1 Enhancing the proficiency level of the team.
     - 4.1.2 Correcting identified deficiencies or weaknesses.
     - 4.1.3 A variety of locations, environmental conditions, and search area sizes.
     - 4.1.4 A varied duration of search times at a variety of times of day.
     - 4.1.5 A variety of blank search areas.
     - 4.1.6 A variety of search areas that contain nonmatching scent trails.
     - 4.1.7 A variety of distractions in the search area.
     - 4.1.8 A variety of set times.
     - 4.1.9 A variety of targets and scent articles.
     - 4.1.10 A variety of methods of concealment.
   - 4.2 Routine training conducted solely by the handler to maintain the canine's proficiency is acceptable but shall be combined with supervised training on a regular basis.
   - 4.3 Supervised training is conducted by a qualified trainer or instructor other than the handler, in order to improve performance, identify and correct training deficiencies, and perform proficiency assessments.
   - 4.4 Trailing training shall be included in the minimum of 16 hours of training per month to maintain and improve the proficiency level of the canine team.
   - 4.5 The canine team shall perform periodic proficiency assessments throughout the certification period as outlined in Section 2—"Canine Team Assessments," including a variety of scent recognition assessments, comprehensive assessments, and double-blind assessments.

5. Records and Document Management
   - 5.1 The handler and department or organization shall keep regular maintenance training, seizure, and deployment or utilization records.
   - 5.2 Proficiency assessments and training records may be combined or separate documents.
   - 5.3 Deployment or utilization and seizure records shall be separated from training, proficiency assessment, and certification records.
   - 5.4 Training and discipline-related records should be standardized within the department or organization.
   - 5.5 Training records may include, but are not limited to the following data:
     - 5.5.1 Name of handler and canine.
     - 5.5.2 Names of individuals conducting or assisting with training.
     - 5.5.3 Time and date of training.
     - 5.5.4 Location and environmental conditions of training.
     - 5.5.5 Training design (nonblind, single-blind, or double-blind).
     - 5.5.6 Description of targets.
     - 5.5.7 Location of targets.
     - 5.5.8 Set time.
     - 5.5.9 Length of trail.
     - 5.5.10 Length of training session.
     - 5.5.11 Search results.
     - 5.5.12 Deficiencies and corrective measures implemented during training regimen.
     - 5.5.13 Other information required by the canine team's department or organization.
   - 5.6 Certification records shall be kept by the certifying authority and the handler and include the following information:
     - 5.6.1 Name of canine and handler.
     - 5.6.2 Date team certified.
     - 5.6.3 Certification authority, i.e., agency, professional organization, or individuals.
     - 5.6.4 The standard or guideline to which the canine team is certified.
     - 5.6.5 Name of individuals awarding certification.
     - 5.6.6 Search area types included in certification assessment.
     - 5.6.7 Location of certification.
   - 5.7 Proficiency assessment records kept by the handler, organization and/or department may include but are not limited to the following data:
     - 5.7.1 Name of handler and canine.
     - 5.7.2 Names of individuals conducting assessment.

  - 5.7.3 Time and date of assessment.
  - 5.7.4 Location and environmental conditions of assessment.
  - 5.7.5 Assessment design (single-blind or double-blind).
  - 5.7.6 Description of targets.
  - 5.7.7 Location of targets.
  - 5.7.8 Set time.
  - 5.7.9 Length of trail.
  - 5.7.10 Proficiency assessment results.
  - 5.7.11 Other information required by the canine team's department or organization.
- 5.8 Supervisory review of all records is recommended.
- 5.9 Digitally formatted records are recommended to facilitate compiling and analyzing data.
- 5.10 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by the canine team's departmental or organizational guidelines.
- 5.11 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
- 5.12 Confirmed operational outcomes can be used as a factor in determining capability.
  - 5.12.1 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine team's proficiency.
- 5.13 Veterinary records.
  - 5.13.1 Veterinary records shall be maintained in a manner such as they are accessible to the handler/department/organization.
  - 5.13.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

SWGDOG SC9—Human Scent Dogs

Avalanche Search

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Avalanche Searches

Avalanche canines are typically used in areas such as ski areas, wilderness, highways, and towns/villages including houses, to locate victims who are trapped in snow. The canine will cover the area independently and thoroughly, and give a recognizable alert (either passive or active) upon locating the target(s). This document focuses on the tasks the canine team is expected to perform, and describes the methodology needed to obtain certification.

Statement of Purpose: to provide recommended guidelines for training, certification, and documentation pertaining to avalanche search canines.

1. Initial Training
   - 1.1 The canine shall be trained by a qualified canine trainer from an entity that uses a structured curriculum with specific training and learning objectives.
   - 1.2 The handler shall be trained by a qualified canine trainer from an entity that uses a structured curriculum with specific training and learning objectives.
   - 1.3 Handler training shall include, but is not limited to the following topics:
     - 1.3.1 Search planning techniques, tactics, safety, and equipment.
     - 1.3.2 Scent dispersion and how it is affected by environmental conditions (i.e., movement of moisture within the slide and how it affects scent emanations and canine alerts).
     - 1.3.3 First aid and CPR for the canine team, target(s), and victims.
     - 1.3.4 Pertinent National Incident Management System (NIMS) training: ICS 100, 200, IS 700, 800, and/or any applicable updates.
     - 1.3.5 Blood-borne pathogens.
     - 1.3.6 Hazmat awareness.
     - 1.3.7 Avalanche awareness (National Ski Patrol level 1 or level 2, or equivalent).
     - 1.3.8 Winter survival training.
     - 1.3.9 Mountain rescue.
     - 1.3.10 Canine team helicopter safety/transportation.
     - 1.3.11 Canine team chairlift evacuation.
     - 1.3.12 Canine team snow mobile transportation.
     - 1.3.13 Handler snowshoe, downhill, and/or cross-country skiing.
   - 1.4 The handler should be trained to correctly use the following equipment:
     - 1.4.1 Probe pole
     - 1.4.2 Shovel
     - 1.4.3 Transceiver
     - 1.4.4 Radio protocols
     - 1.4.5 GPS

1.5 Initial canine training shall include sufficient obedience training to ensure the canine will operate effectively based on mission requirements.

1.6 Initial training shall include a behavioral assessment of the canine, in search and rescue applications, to identify and dismiss those canines prone to unprovoked attacks on humans and/or animals.

1.7 The canine shall be trained to perform a predetermined specific alert (passive or active).

1.8 Initial training shall include exposing the canine team to a variety of locations, expected situations, searches, and modes of transportation (helicopter, chairlift, snow mobile, and/or snow shoe/skiing). This may include but is not limited to an avalanche environment where human-scented articles (such as skis, ski poles, gloves, backpacks, etc.) or distractor scent sources (animal, fuel, human, or canine urine, etc.) could be present, as well as noise distractions (e.g., people, explosions, snow mobiles, generators, helicopters.). It is important to simulate the chaos, confusion, and contamination that the canine team may be exposed to on a real avalanche.

1.9 The canine team's training shall include effective search strategy: hasty search and grid search.

1.10 The training shall be structured to meet the typical mission requirements of the canine team's department/organization.

1.11 The canine team's training shall be continued to achieve a level of operational proficiency until certification evaluation.

2. Canine Team Assessments

2.1 Assessments are part of certification, maintenance training, and proficiency.

2.2 Each assessment is the evaluation of a search.

2.3 The canine team shall be assessed in the following ways:

2.3.1 An odor recognition assessment: with the purpose of evaluating the canine team's ability to indicate on live subjects only and not on nonhuman distractors. The handler shall be advised of the parameters of the search, the number of targets (not placement), and the assessor shall know the desired outcome of the search. The odor recognition assessment shall evaluate the following:

2.3.1.1 The handler's interpretation of the canine's behavior.

2.3.1.2 The canine team's ability to locate all relevant human targets.

2.3.1.3 The canine's response to a human target.

2.3.1.4 The canine's ability to ignore distractions.

2.3.2 An odor recognition assessment consists of a single search and shall be set up according to the following parameters:

2.3.2.1 A separate area containing a minimum of five snow caves/holes will be set up in an area of approximately 1000 square meters (¼ acre). The area shall be clearly marked, with the caves/holes approximately five (5) meters (15 feet) apart.

2.3.2.2 The snow caves/holes should be made to give the optimum control of scent. The snow caves/holes need to be constructed to prevent canine penetration and shall include:

2.3.2.2.1 Two blank snow caves.

2.3.2.2.2 Two snow caves/holes with nonhuman-scented distractors (food and snow/ski equipment).

2.3.2.2.3 One snow cave with the target.

2.3.2.3 The handler shall have a clear line of sight of the canine in the snow cave area.

2.3.2.4 The target and all distractors shall be placed approximately 10 minutes before the start of the assessment.

2.3.2.5 The team shall have 5 minutes to complete the exercise.

2.3.2.6 The target shall not be known to the canine.

2.3.2.7 The assessor shall inform the handler of the search parameters.

2.3.2.8 The handler shall advise the assessor of how his/her canine works.

2.3.2.9 The handler must disclose the canine's response prior to the start of the assessment.

2.3.2.10 The assessor shall know the location of the target.

2.3.2.11 The canine must locate and alert on the target independently of specific directions from the handler.

2.3.2.12 Any false response constitutes a failure.

2.3.3 Comprehensive assessment (single-blind assessment). A comprehensive assessment examines the level of competence based on an average sized avalanche search area. The objective of the comprehensive assessment is to test the canine team's skills as they relate to the following:

2.3.3.1 The handler's ability to set up a logical, systematic search pattern utilizing the wind and terrain to the canine's advantage.
2.3.3.2 The canine's ability to perform an effective independent search without continuous handler guidance.
2.3.3.3 The canine's ability to search among distractions.
2.3.3.4 The canine's ability to recognize scent emanating from a live person(s) and respond to that scent with a final response.
2.3.3.5 The handler's ability to interpret his or her canine's alert and articulate to the assessor when and where the target(s) is located.
2.3.3.6 The handler's ability to conclude the search (no one left to find).
2.3.3.7 The assessment shall occur in an avalanche environment similar to actual search conditions. Typically, this is an avalanche environment where target or distractor scent sources could be present, as well as noise distractions. It is important to simulate the environment that the canine team might be exposed to while working a real avalanche.
2.3.3.8 The assessment area shall measure approximately 4050 square meters (approximately 1 acre) in size, unless the certifying agency specifies a search area more appropriate to the regional terrain. If the avalanche site provided is larger than required, the search area may be reduced and marked, using flagging or area security tape. If at all possible, the assessment area should be prepared, and caves/holes dug a day in advance of the assessment to minimize the residual scent of the burial sites. The assessment site should be designed to simulate human contamination, e.g., snowshoe, ski, and snow machine tracks, that one might find when responding to an avalanche. There must be enough caves/holes prepared to allow for multiple burials. There should be open snow caves/holes as well as covered snow caves/holes. Additional snow caves/holes can be dug, as needed.

2.3.3.9 One to two targets shall be placed into snow caves/holes, buried approximately 1 meter to 2 meters (3–6 feet) in depth in the search area, in such a way as to encourage the use of air scenting. The target(s) shall be placed as to be inaccessible and invisible to the canine team.

2.3.3.9.1 The snow caves/holes shall be constructed in such a way as to ensure adequate air space as well as movement for the target (confined space requirements). The snow caves/holes with the target inside shall be sealed with a minimum of approximately 1 meter (3 feet) of compacted snow. There shall be no partial burials.

2.3.3.9.2 Distractions and debris such as rescue equipment, shovels, probes, articles of clothing, and snow equipment (i.e., skis, ski poles, snowboards, or snowmobile parts) may be left in the assessment area. They may be buried, partially buried, or on the snow surface. They shall not be placed on or buried within 3 meters (approximately 10 feet) of the target(s).

2.3.3.9.3 To prevent a sterile environment, the assessment site shall include human scent trails not associated with the buried target(s) to simulate a realistic avalanche working situation.

2.3.3.9.4 If there are more canine teams testing than the time allows for the target(s) to be buried (up to 60 minutes), the target(s) will be unburied, and one to two new targets shall be placed into new unused snow caves/holes.

2.3.3.9.5 Used snow caves/holes would then be identified verbally as “holes where recoveries were made earlier,” as would be expected in an actual event.

2.3.3.10 Care must be exercised to ensure the safety of all involved in the assessment, especially the buried target(s).

  2.3.3.10.1 The target(s) shall not be known to the handler.

  2.3.3.10.2 There shall be radio contact at all times with the buried target(s) (earpieces are preferred), and their transceivers shall be turned to transmit.

  2.3.3.10.3 The target(s) shall be instructed to be nonresponsive to the canine team.

  2.3.3.10.4 All target(s) shall be placed no less than 10 minutes prior to the beginning of the assessment, and no target(s) will be buried over 60 minutes.

2.3.3.11 Search time shall not exceed 20 minutes. If the handler removes his or her canine from the avalanche area for any purpose during their search, that time is counted as part of their search time.

  2.3.3.11.1 The handler shall decide how to work his or her canine and will inform the assessor.

  2.3.3.11.2 The handler may not use a transceiver to assist in locating the target(s).

  2.3.3.11.3 The handler will work the area as if working on an actual avalanche search and perform a debriefing whether or not all finds were made.

  2.3.3.11.4 It is the handler's responsibility to report to the assessor when the canine has alerted. At that time, the handler will mark the spot with a flag/marker (the handler may *not* probe the area, but may use a shovel to aerate the area), call for a shoveler, and continue to search for other potential targets. The handler may send his or her canine back into an area to confirm a find, at his or her discretion.

2.3.3.12 One person will be assigned as the safety observer. The safety observer will maintain radio contact with the target(s) during the assessment. There will always be at least one person assigned as a shoveler to each target.

2.3.3.13 All personnel, when working on or near an avalanche site, will wear a transceiver, and will be knowledgeable in its use, as well as carry a radio, shovel, and probe.

2.3.3.14 Any false alert called by the handler constitutes a failure. A canine showing interest in any article containing human scent is not considered a failure, but if the handler calls it as an alert, it constitutes a failure.

2.3.3.15 The canine team must locate 100% of the target(s).

2.3.3.16 A canine team which fails to complete the certification process shall complete a corrective action plan before making another attempt to certify.

2.3.4 Double-blind assessments shall only be conducted in situations where safety is not an issue.

3. Canine Team Certification

3.1 Certification for the named canine team shall be valid for one year.

3.1.1 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.

3.1.2 The certifying official(s) shall not routinely be involved in the day-to-day training of the canine team being evaluated.

3.1.3 The certification shall be comprised of a comprehensive assessment which incorporates an odor recognition assessment to such an extent that a separate odor recognition test is not necessary, but recommended.

3.1.4 Handler errors, when excessive, may result in failure of the team.

3.1.5 A mission-oriented test environment shall be used.

3.1.6 A double-blind assessment shall only be conducted in situations where safety is not an issue.

4. Maintenance Training
   - 4.1 The canine team shall conduct regular objective-oriented training sufficient to maintain and enhance operational proficiency.
   - 4.2 Training is meant to sustain, enhance, and promote the performance of the canine team.
   - 4.3 Canine teams shall be challenged during the regular maintenance training sessions within the operational environments for which the team may be deployed.
     - 4.3.1 Training shall include exposure to:
       - 4.3.1.1 A variety of locations, expected situations, searches, and modes of transportation.
       - 4.3.1.2 A variety of human targets.
       - 4.3.1.3 A varied number of human targets.
       - 4.3.1.4 A variety of expected human scents.
       - 4.3.1.5 A variety of distractor scent sources.
       - 4.3.1.6 A variety of noise distractions.
       - 4.3.1.7 A varied duration of search times and times of day and night.
       - 4.3.1.8 A variety of blank search areas.
       - 4.3.1.9 A variety of methods and degrees of concealment.
     - 4.3.2 Routine training conducted solely by the handler to maintain his or her canine's proficiency is acceptable, but should be periodically combined with supervised training.
       - 4.3.2.1 Supervised training by a qualified trainer or instructor is recommended in order to monitor and improve performance, identify and correct training deficiencies, and perform proficiency assessments.
     - 4.3.3 Avalanche training shall be included, when environmental conditions are appropriate, in the canine team's minimum of 16 hours of training per month, to maintain and improve the proficiency level of the team.
     - 4.3.4 The canine team shall perform periodic proficiency assessments throughout the certification period as outlined in Section 2—"Canine Team Assessments," including a variety of odor recognition assessments, comprehensive assessments, and double-blind assessments (safety dependent).

5. Record Keeping and Document Management
   - 5.1 The handler/department/organization shall document training, certification, proficiency assessments, and discipline-related deployment data.

  5.1.1 Training and proficiency assessment records may be combined or maintained separately.
  5.1.2 Discipline-related deployment records shall be maintained separately from training, certification, and proficiency assessment records.
  5.1.3 Training and discipline-related records should be standardized within the department/organization.
5.2 Training records may include, but are not limited to, the following data:
  5.2.1 Name of handler and canine.
  5.2.2 Name(s) of individual(s) conducting/assisting training.
  5.2.3 Time and date training took place.
  5.2.4 Location and environmental conditions.
  5.2.5 Training design (nonblind, single-blind, or double-blind).
  5.2.6 Description and number of target(s).
  5.2.7 Location of target(s).
  5.2.8 Set time.
  5.2.9 Size of search area.
  5.2.10 Length of session.
  5.2.11 Search results.
  5.2.12 Deficiencies and corrective measures implemented.
  5.2.13 Other information required by department/organization.
5.3 Certification records shall be maintained by the certifying authority and the handler, and include the following information:
  5.3.1 Name of handler and canine.
  5.3.2 Date team certified.
  5.3.3 Certification authority, i.e., agency, professional organization, and/or individual(s).
  5.3.4 The standard or guideline under which the canine team is certified.
  5.3.5 Name of individual(s) awarding certification.
  5.3.6 Search area types included in certification assessment.
  5.3.7 Location of certification.
  5.3.8 Set time.
5.4 Proficiency assessment records maintained by the handler/department/organization may include, but are not limited to, the following data:
  5.4.1 Name of handler and canine.
  5.4.2 Name(s) of individual(s) conducting assessment.
  5.4.3 Time and date assessment took place.
  5.4.4 Location and environmental conditions.
  5.4.5 Assessment design (single-blind or double-blind).
  5.4.6 Search area types included in proficiency assessment.

- 5.4.7 Set time.
- 5.4.8 Size of search area.
- 5.4.9 Proficiency assessment results.
- 5.4.10 Other information required by department/organization.

5.5 Supervisory review of all records is recommended.

5.6 Keeping records in a digital format is recommended to facilitate compiling and analyzing data.

5.7 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by departmental/organizational guidelines.

5.8 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.

5.9 Confirmed operational outcomes can be used as a factor in determining capability.

5.10 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine team's proficiency, i.e., residual scent can be present or concealment may preclude discovery.

5.11 Veterinary records.

- 5.11.1 Veterinary records shall be maintained in a manner such as they are accessible to the handler/department/organization.
- 5.11.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

SWGDOG SC9—Human Scent Dogs

Nonspecific Human Scent Wilderness Area Search (Air Scent)

Posted for public comment 1/19/2010–3/19/2010. Approved by the membership 3/2/2010.

Nonspecific human scent wilderness area searches are used to locate live people in unpopulated wilderness areas through air scenting by a trained canine team. The goal of this type of search is for the canine team to utilize the wind by way of air scenting and to search for and detect live people within a defined search area. This differs from other types of searches where the canine follows the target's foot track.

Statement of purpose: To provide recommended guidelines for training, certification, and documentation pertaining to nonspecific human scent wilderness area search canines.

1. Initial Training
    - 1.1 The handler shall be trained by a competent, qualified, nonspecific human scent wilderness area canine trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
    - 1.2 The canine shall be trained by a competent individual or entity through a structured curriculum with specific training and learning objectives.
    - 1.3 Initial training shall include a level of obedience to ensure the canine will operate effectively based on mission requirements.
    - 1.4 The canine shall be trained to perform an effective, independent, controlled search on or off lead.
    - 1.5 The initial training of the canine shall include training of a determined specific final response (active or passive) upon locating the victim.
    - 1.6 Initial training shall include exposing the canine team to a variety of locations and expected situations.
    - 1.7 The training shall be structured to meet the typical mission requirements of the canine team's department or organization.
    - 1.8 Handler training shall include the following topics:
        - 1.8.1 Search techniques, tactics, and equipment.
        - 1.8.2 Environmental conditions that affect odor dispersion, in order to maximize the team's search efficiency.
        - 1.8.3 First aid for canine team and subject.
        - 1.8.4 Pertinent National Incident Management System (NIMS) classes (i.e., ICS 100 and 200, and IS 700 and any applicable updates), which can be taken online.
    - 1.9 The canine team's training shall be continued until a level of operational proficiency is achieved and the team is certified.
2. Canine Team Assessments
    - 2.1 Assessments are part of certification, maintenance training, and proficiency testing.
    - 2.2 Assessment parameters should be appropriate to operational requirements. Nonspecific scent wilderness area search canines can be deployed in a wide variety of circumstances.
    - 2.3 Each assessment is the evaluation of a search.

2.4 The canine team shall be assessed as follows:
  2.4.1 Odor recognition assessments shall evaluate:
    2.4.1.1 The handler's ability to organize and articulate a logical and systematic search pattern utilizing the wind and terrain to the canine's advantage.
    2.4.1.2 The handler's ability to perform a systematic search with the canine.
    2.4.1.3 The handler's interpretation of the canine's behavior.
    2.4.1.4 The canine team's ability to locate all relevant human targets.
    2.4.1.5 The canine's ability to perform an effective independent search without continuous handler guidance.
    2.4.1.6 The canine's response to a human target.
    2.4.1.7 The handler's interpretation of the canine's response.
    2.4.1.8 The canine's ability to ignore distractions.
  2.4.2 An odor recognition assessment consists of a single search:
    2.4.2.1 The assessment shall occur in an environment similar to where the canine usually works in daylight hours. Typically, this is an unpopulated environment where animals and human-scented objects may be present.
    2.4.2.2 The search area shall be approximately 20,000 m^2 (5 acres) in size.
    2.4.2.3 One target shall walk into the search area in such a way as to encourage the use of air scenting. The target shall hide in a stationary position, but not in an enclosed location (i.e., tents, caves, sleeping bags).
      2.4.2.3.1 The target shall not be a person routinely or recently used as a target to train the canine.
      2.4.2.3.2 The handler shall know the number of the targets, but not the placement.
    2.4.2.4 For multiple assessments run consecutively, the target position shall be different for each assessment. It is recommended that a new search area is used for each team.
    2.4.2.5 Set time and search time shall be determined by the certifying authority and shall be dependent

on the terrain, vegetative cover, and by operational requirements. A typical search time for approximately 20,000 m^2 (5 acres) would be under 30 minutes.

2.4.2.6 The evaluating official shall inform the handler of the search parameters, which will include the area to be searched and the number of human targets to be located.

2.4.2.7 The handler shall decide to work with the canine on or off lead depending on the operational requirements, training, and trained canine response.

2.4.2.8 The handler shall advise the evaluating official of his or her decision. Should conditions necessitate a change in that decision, the handler shall notify the evaluating official what prompted the change to his or her original decision.

2.4.2.9 The handler must disclose the canine's response prior to the start of the assessment.

2.4.2.10 The handler shall demonstrate a logical, systematic search pattern utilizing the wind and terrain to the canine's advantage.

2.4.2.11 The evaluating official shall know the location of the target(s) and desired outcome of the search.

2.4.2.12 The canine must locate and alert on the target(s) independent of specific directions from the handler.

2.4.2.13 Any false response constitutes a failure.

2.4.3 Comprehensive assessments test the following:

2.4.3.1 The handler's ability to set up a logical, systematic search pattern utilizing the wind and terrain to the canine's advantage.

2.4.3.2 The handler's ability to perform a systematic search with the canine.

2.4.3.3 The canine team's ability to locate all relevant human targets.

2.4.3.4 The canine's ability to conduct a search pattern.

2.4.3.5 The canine's response to a human target.

2.4.3.6 The handler's interpretation of the canine's response.

2.4.3.7 The canine's ability to ignore distractions.

2.4.3.8 The handler's ability to conclude the search (no one left to find).

2.4.4 Comprehensive assessments (single-blind assessments) examine a level of competence based on an average-sized search area. Larger search areas can be tested through proficiency testing.

2.4.4.1 The assessment shall occur in an environment similar to actual search conditions (including day or night). Typically, this is an unpopulated environment where animal and human-scented objects may be present.

2.4.4.2 The assessment area shall be between 0.16–0.24 km^2 (40–60 acres) in size unless the certifying agency specifies a search area more appropriate to the regional terrain.

2.4.4.3 One to three targets shall walk into the search area in such a way as to encourage the use of air scenting. The target(s) may hide in a stationary position, in an enclosed location (i.e., tents, caves, sleeping bags) or may be moving as specified by the assessing agency, but shall not deliberately evade.

2.4.4.3.1 The target(s) shall not be a person routinely or recently used to train the canine.

2.4.4.3.2 The handler shall not know the number or placement of the targets.

2.4.4.4 The target positions shall be unique for each assessment. It is recommended that a new search area be used for each team.

2.4.4.5 Set time and search time shall be determined by the certifying agency and shall be dependent on the terrain, vegetative cover, and by operational requirements. Typical search times for 0.16–0.24 km^2 (40–60 acres) would not exceed 2 hours including rest periods.

2.4.4.6 The handler shall be provided with a map of the search area.

2.4.4.7 The handler shall decide to work with the canine on or off lead depending on the operational requirements, training, and trained canine response and shall advise the evaluating official of his or her decision. Should conditions necessitate a change in that decision, the handler shall notify the evaluating official regarding the reasons for the change.

- 2.4.4.8 The handler must articulate the canine's response to the evaluating official prior to the start of the assessment.
- 2.4.4.9 The evaluating official(s) shall know the location of the target(s).
- 2.4.4.10 The evaluating official(s) shall know the outcome of the search.
- 2.4.4.11 The handler shall demonstrate a logical, systematic search pattern utilizing the wind and terrain to the canine's advantage.
- 2.4.4.12 If there are multiple targets, the handler shall restart at a location of their choosing to ensure efficient coverage of the search area.
- 2.4.4.13 Once a target has been located, the certifying agency shall specify whether the target stays in place or leaves the area.
- 2.4.4.14 The canine must locate and should perform its trained final response on the target independent of specific directions from the handler.
- 2.4.4.15 Any false indication or nonfind constitutes a failure.
- 2.4.4.16 The assessments shall include a blank search.
- 2.4.4.17 The team must locate all targets.
- 2.4.4.18 The handler must be able to determine when there are no targets left to find.
- 2.4.4.19 At the conclusion of the search the handler shall document the following on the map provided: the area covered, and the number and position of all targets found.

2.4.5 Double-blind assessments demonstrate the proficiency of the canine team in an operational setting.

- 2.4.5.1 A double-blind assessment shall consist of a single search.
- 2.4.5.2 The assessment shall occur in an environment similar to where and when the canine usually works. Typically, this is an unpopulated environment where animal and human-scented objects may be present.
- 2.4.5.3 The search area size shall depend on operational requirements.
- 2.4.5.4 One to three targets shall walk into the search area in such a way as to encourage the use of air scenting. The target(s) may hide in a stationary

location, an observed location (i.e., tent, cave, sleeping bag), or may be moving, but shall not deliberately evade.

2.4.5.4.1 The targets shall not be persons routinely or recently used to train the canine.

2.4.5.4.2 The handler shall not know the number or placement of the targets.

2.4.5.5 The target positions shall be unique for each assessment.

2.4.5.6 Set time and search time shall be determined by the certifying agency and shall be dependent on the terrain, vegetative cover, and by operational requirements.

2.4.5.7 The handler shall be provided with a map of the search area, but not the number of human targets to be located.

2.4.5.8 Neither the handler, the evaluating official if used, nor any individual present shall know the correct outcome of any portion of assessment.

2.4.5.9 The handler will set up a logical, systematic search pattern utilizing the wind and terrain to the canine's advantage.

2.4.5.10 The canine team will perform a systematic search.

2.4.5.11 The handler shall decide to work with the canine on or off lead depending on the operational requirements, training, and trained canine response and shall advise the evaluating official of his or her decision. Should conditions necessitate a change in that decision, the handler shall notify the evaluating official what prompted the change to his or her original decision.

2.4.5.12 The handler shall start at a location of their choosing.

2.4.5.13 If there are multiple targets, the handler shall restart at a location of his or her choosing to ensure total coverage of the search area.

2.4.5.14 The canine must locate and should perform its trained final response on the target independently of specific directions from the handler.

      - 2.4.5.15 The handler must articulate the canine's response to the evaluating official prior to the start of the assessment.
      - 2.4.5.16 Any false indication or nonfind constitutes a failure.
      - 2.4.5.17 The assessments may include a blank search.
      - 2.4.5.18 The team must locate all targets.
      - 2.4.5.19 The handler must be able to determine when there are no targets left to find.
      - 2.4.5.20 At the conclusion of the search the handler shall document the following on the provided map: the area covered and the number and position of targets found.
      - 2.4.5.21 The evaluating official shall compare the documented search results with the parameters of the search at the conclusion of the assessment.
      - 2.4.5.22 Neither participant nor observer present at the assessment location shall be aware of the desired outcome of the search.

3. Canine Team Certification
   - 3.1 Certification for the named canine team shall be valid for 1 year.
     - 3.1.1 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.
     - 3.1.2 The certifying official(s) shall not be routinely involved in the day-to-day training of the canine team being evaluated.
     - 3.1.3 Handler errors, when excessive, may result in failure of the team.
     - 3.1.4 A mission-oriented test environment shall be used.
   - 3.2 Certification shall consist of a number of assessments that together form the full test.
     - 3.2.1 Each assessment is the evaluation of a search.
     - 3.2.2 Targets used in the day-to-day training activities of the team being certified shall not be used in the certification process.
     - 3.2.3 The certification shall be comprised of a comprehensive assessment together with either an odor recognition assessment or a double-blind assessment, or both.

    3.3 A canine team that fails the certification process shall complete a corrective action plan before making another attempt to certify.

4. Maintenance Training
    4.1 The canine team shall conduct regular objective-oriented training sufficient to maintain and enhance operational proficiency. Maintenance training shall include the following:
        4.1.1 Correcting identified deficiencies or operational concerns.
        4.1.2 A variety of search location areas and environmental conditions in which the team may be deployed.
        4.1.3 Varied duration of search times.
        4.1.4 Varied times of day or night.
        4.1.5 A variety of blank searches.
        4.1.6 A variety of distractions in the search areas.
        4.1.7 A variety of set times.
        4.1.8 A variety of targets and number of targets.
        4.1.9 A variety of hiding or concealment locations.
    4.2 Training conducted solely by the handler to maintain the canine's proficiency is acceptable, but should be periodically combined with supervised training.
        4.2.1 Supervised training, by a qualified trainer or instructor, is recommended in order to monitor and improve performance, identify and correct training deficiencies, and perform proficiency assessments.
    4.3 A canine team shall spend a minimum of 16 hours per month training to maintain and improve the proficiency level of the team.
    4.4 The canine team shall perform periodic proficiency assessments as outlined in Section 2—the "Canine Team Assessments." These assessments should include a variety of odor recognition assessments, comprehensive assessments, and/or double-blind assessments.
5. Records and Document Management
    5.1 The handler, department, or organization shall document training, certification, proficiency assessment, and discipline-related deployment data.
        5.1.1 Proficiency assessments and training records may be combined or separate documents.
        5.1.2 Discipline-related deployment records shall be maintained separately from training, certification, and proficiency assessment records.

    - 5.1.3 Training and discipline-related records should be standardized within the department or organization.
- 5.2 Training records may include, but are not limited to, the following data:
    - 5.2.1 Name of handler and canine.
    - 5.2.2 Names of individuals conducting or assisting in training.
    - 5.2.3 Time and date of training.
    - 5.2.4 Location and environmental conditions of training.
    - 5.2.5 Training design (nonblind, single-blind, or double-blind).
    - 5.2.6 Description and number of targets.
    - 5.2.7 Location of targets.
    - 5.2.8 Set time.
    - 5.2.9 Size of search area.
    - 5.2.10 Length of training session.
    - 5.2.11 Search results.
    - 5.2.12 Deficiencies and corrective measures implemented.
    - 5.2.13 Other information required by the team's department or organization.
- 5.3 Certification records shall be maintained by the certifying authority and the handler and include the following information:
    - 5.3.1 Name of handler and canine.
    - 5.3.2 Date team certified.
    - 5.3.3 Certification authority (i.e., agency, professional organization, or individual).
    - 5.3.4 The standard or guideline to which the canine team is certified.
    - 5.3.5 Name of individual(s) awarding certification.
    - 5.3.6 Search area types included in assessment certification.
    - 5.3.7 Location of certification.
    - 5.3.8 Set time.
- 5.4 Proficiency assessment records maintained by the handler, department, or organization may include, but are not limited to, the following data:
    - 5.4.1 Name of handler and canine.
    - 5.4.2 Names of individuals conducting assessment.
    - 5.4.3 Time and date of assessment.
    - 5.4.4 Location and environmental conditions of assessment.
    - 5.4.5 Assessment design (single-blind or double-blind).
    - 5.4.6 Search area types included in the assessment.
    - 5.4.7 Description and number of targets.
    - 5.4.8 Location of targets.
    - 5.4.9 Set time.

  - 5.4.10 Size of search area.
  - 5.4.11 Proficiency assessment results.
  - 5.4.12 Other information required by the team's department or organization.
- 5.5 Supervisory review of all records is recommended.
- 5.6 Digitally formatted records are recommended to facilitate compiling and analyzing data.
- 5.7 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by the team's department or organization guidelines.
- 5.8 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
- 5.9 Confirmed operational outcomes can be used to determine capability.
- 5.10 Unconfirmed operational outcomes shall not be used to determine capability in that they do not correctly evaluate a canine team's proficiency.
- 5.11 Veterinary records.
  - 5.11.1 Veterinary records shall be maintained in a manner allowing accessibility to the handler, department, or organization.
  - 5.11.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

SWGDOG SC9—Human Scent Dogs

Prescented Canines—Location Check

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Location checks are used to identify the presence or absence of the scent of a specific person to the exclusion of all other scents at a given location. In this discipline, the canine is used to scent match a "prescented" object or pad to the scents present at the check site. This technique may be used for subject exclusion or inclusion scent checks. Dogs may indicate a scent match and follow the scent trail or may indicate a match by a passive or active response.

Statement of purpose: To provide recommended guidelines for training, certification, and documentation pertaining to canines trained to conduct location checks.

1. Initial Training
   - 1.1 The handler training shall be conducted by a competent trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
   - 1.2 Handler training shall include the following:
     - 1.2.1 Environmental conditions affecting scent dispersion.
     - 1.2.2 Techniques for collecting human scent evidence.
     - 1.2.3 Techniques for conducting and interpreting location checking.
     - 1.2.4 Relevant canine legal aspects.
   - 1.3 The canine training shall be conducted by a competent canine trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
   - 1.4 Initial training shall include sufficient obedience training to ensure the canine will operate effectively based on mission requirements.
   - 1.5 The canine shall be trained to perform an effective and controlled search.
   - 1.6 The initial training of the canine shall include training of a specific final negative and a specific final positive alert.
   - 1.7 Initial training shall include exposing the canine team to a variety of locations, expected situations, and searches.
   - 1.8 The training shall be structured to meet the typical mission requirements of the canine team's department or organization.
   - 1.9 Training shall include exposing the canine to a variety of different types of locations, noise distractors, scent distractors, and environments.
   - 1.10 The canine team's training shall be continued until a level of operational proficiency is achieved and the team is certified.
2. Canine Team Assessments
   - 2.1 Assessments are part of certification, maintenance training, and proficiency testing.
   - 2.2 Each assessment is the evaluation of a search.
   - 2.3 The canine team shall be assessed in the following ways:
     - 2.3.1 Comprehensive assessments shall test the following:
       - 2.3.1.1 The ability of the canine to indicate the presence or absence of the target human scent.
       - 2.3.1.2 The handler's interpretation of the canine's behavior.

2.3.1.3 The canine's alert.
2.3.1.4 The handler's interpretation of the canine's alert.

2.3.2 Comprehensive assessments shall be set up as described below:

2.3.2.1 At least six location checks, with the scent of at least two different human targets, in at least three different areas, with different human distractors shall be performed in this assessment.
2.3.2.2 At least half of the location checks shall be negative.
2.3.2.3 A negative location check shall have scent or a scent trail present, but the human scent traces on the prescenting article will not match the scent trail.
2.3.2.4 A positive location check shall have scent or a scent trail present that matches the human scent traces on the prescenting article.
2.3.2.5 Each location check shall be conducted in an environment similar to that where the canine usually works.
2.3.2.6 The matching scent shall be aged in accordance with requirements set by the assessing agency.
2.3.2.7 If a trail is used, it shall be a minimum of 45 meters (≈ 50 yds.) in length.
2.3.2.8 The handler shall be informed of the start location.
2.3.2.9 The handler shall be provided with a new scent sample from a matching target or a nonmatching target at each location check.
2.3.2.10 The handler shall specify the type of scent sample (object, scent pad) prior to the assessment.
2.3.2.11 Each location check shall be completed in less than 5 minutes.
2.3.2.12 The assessor shall know the correct outcome of each location check.
2.3.2.13 The handler shall not know the correct outcome of each location check, nor the number of checks to be conducted.
2.3.2.14 The canine shall be required to correctly indicate the presence or absence of the matching scent at each start location.
2.3.2.15 The handler must be able to discern the canine's final alert and communicate this to the assessor.

        - 2.3.2.16 At least 80% of the location checks shall be performed correctly.
    - 2.3.3 Double-blind assessments demonstrate the proficiency of the canine team in an operational setting.
        - 2.3.3.1 One or more targets may be utilized to create a scent location or lay scent trails in the search area.
        - 2.3.3.2 The search area or trail age and scent sample shall be appropriate to operational requirements.
        - 2.3.3.3 The assessment will include negative scent match check locations.
        - 2.3.3.4 Neither the handler, nor the assessor, nor any individual present with the canine team shall know the correct outcome of any portion of the assessment, including whether there is a scent match.
        - 2.3.3.5 The assessment may or may not be timed.
        - 2.3.3.6 The assessor shall observe the canine team and compare the search results with the parameters of the search at the conclusion of the assessment. This may be done immediately after the handler concludes his canine has made its trained alert, or after the conclusion of the whole assessment.

3. Canine Team Certification
    - 3.1 Certification for the named canine team shall be valid for one year.
    - 3.2 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.
    - 3.3 The certifying officials shall not be routinely involved in the day-to-day training of the canine team being evaluated.
    - 3.4 Handler errors, when excessive, may result in failure of the team.
    - 3.5 A mission-oriented test environment shall be used.
    - 3.6 Certification shall consist of a number of assessments that together form the full test.
    - 3.7 Each assessment is the evaluation of a search.
    - 3.8 Targets used in the certification process shall not have been used in the day-to-day training activities of the team being certified.
    - 3.9 The certification shall be comprised of a comprehensive assessment which incorporates scent recognition to such an extent that a separate scent recognition test is not necessary. The comprehensive assessment may be combined with a double-blind assessment.

3.10 A canine team that fails the certification process shall complete a corrective action plan before making another attempt to certify.

4. Maintenance Training
   - 4.1 The canine team shall conduct regular objective-oriented training that includes:
     - 4.1.1 Enhancing the proficiency level of the team.
     - 4.1.2 Correcting identified deficiencies or weak areas.
     - 4.1.3 A variety of locations, environmental conditions, and search area sizes.
     - 4.1.4 A varied duration of search times at different times of day.
     - 4.1.5 A variety of blank search areas.
     - 4.1.6 A variety of distractions in the search area.
     - 4.1.7 A variety of set times.
     - 4.1.8 A variety of targets and articles used for prescenting the canine.
   - 4.2 Routine training conducted solely by the handler to maintain the canine's proficiency is acceptable but should be combined with supervised training on a regular basis.
   - 4.3 Supervised training by a qualified trainer or instructor is recommended in order to improve performance, identify and correct training deficiencies, and perform proficiency assessments.
   - 4.4 A canine team shall conduct a minimum of 16 hours of training per month to maintain and improve the proficiency level of the team.
   - 4.5 The canine team shall perform periodic proficiency assessments throughout the certification period as outlined in Section 2—the "Canine Team Assessments," including a variety of scent recognition assessments, comprehensive assessments, and double-blind assessments.
5. Records and Document Management
   - 5.1 The handler and his or her department or organization shall document training, certification, proficiency assessments, and discipline-related deployment records.
   - 5.2 Proficiency assessments and training records may be combined or separate documents.
   - 5.3 Discipline-related deployment records shall be separated from training, proficiency assessment, and certification documentation.
   - 5.4 Training and discipline-related records should be standardized within the department or organization.

5.5 Training records may include, but are not limited to the following data:
  5.5.1 Name of handler and canine.
  5.5.2 Names of individuals conducting or assisting with training.
  5.5.3 Time and date of training.
  5.5.4 Location and environmental conditions of training.
  5.5.5 Training design (nonblind, single-blind, or double-blind).
  5.5.6 Description of targets.
  5.5.7 Location of targets.
  5.5.8 Set time.
  5.5.9 Size of search area.
  5.5.10 Length of training session.
  5.5.11 Search results.
  5.5.12 Deficiencies and corrective measures implemented during training regimen.
  5.5.13 Other information required by canine team's department or organization.
5.6 Certification records shall be kept by the certifying authority and the handler and shall include the following information:
  5.6.1 Name of canine and handler.
  5.6.2 Date team certified.
  5.6.3 Certification authority, that is, agency, professional organization, or individuals.
  5.6.4 The standard or guideline to which the canine team is certified.
  5.6.5 Name of individuals awarding certification.
  5.6.6 Search area types included in certification assessment.
  5.6.7 Name and description of targets and locations included in certification assessment.
  5.6.8 Location of certification.
5.7 Proficiency assessment records kept by the handler and organization or department may include but are not limited to the following data:
  5.7.1 Name of handler and canine.
  5.7.2 Names of individuals conducting assessment.
  5.7.3 Time and date of assessment.
  5.7.4 Location and environmental conditions of assessment.
  5.7.5 Assessment design (single-blind or double-blind).
  5.7.6 Description of targets.
  5.7.7 Location of targets.
  5.7.8 Set time.
  5.7.9 Size of search area.

  - 5.7.10 Proficiency assessment results.
  - 5.7.11 Other information required by the canine team's department or organization.
- 5.8 Supervisory review of all records is recommended.
- 5.9 Digitally formatted records are recommended to facilitate compiling and analyzing data.
- 5.10 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by the canine team's department or organization guidelines.
- 5.11 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
- 5.12 Confirmed operational outcomes can be used as a factor in determining capability.
- 5.13 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine/handler team's proficiency.
- 5.14 Veterinary records.
  - 5.14.1 Veterinary records shall be maintained in a manner such as they are accessible to the handler and his or her department or organization.
  - 5.14.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

SWGDOG SC9—Human Scent Dogs

Scent Identification Line-Ups

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Scent identification line-ups are canine examinations of human scent traces, in a comparative manner, in order to confirm the presence or absence of a match between objects or scent samples.[*]

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[*] Scent identification line-ups are primarily used in criminal investigations. These line-ups can assist investigators in identifying or eliminating suspects in cases where human scent has been collected as evidence. Highly trained canines conduct scent identification line-ups according to a set of strictly administered protocols. Protocols address topics such as: human scent evidence collection, preservation and storage; line-up material preparation; scent identification line-up preparation of both control and target line-up; line-up protocols; department/agency specific procedures.

Statement of Purpose: To provide recommended best practice general guidelines for training, certification, and documentation pertaining to canines trained in conducting scent identification line-ups.

1. Initial Training
   - 1.1 The handler training shall be conducted by a competent trainer from an entity that utilizes a structured curriculum with specific training and learning objectives to achieve scent identification. The handler's training shall include the following topics:
     - 1.1.1 Human odor and factors influencing scent identification.
     - 1.1.2 Environmental conditions affecting odor dispersion.
     - 1.1.3 Proper handling, storage, and disposition of objects used for prescenting the canine as required by the canine team's department or agency.
     - 1.1.4 Proper techniques for evidence collection as required by the canine team's department or agency.
     - 1.1.5 Proper collection, storage, and disposition of line-up odor materials as required by the canine team's department or agency.
     - 1.1.6 Proper preparation of the line-up according to the protocol required by the canine team's department or agency.
   - 1.2 The canine training shall be conducted by a competent canine trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
   - 1.3 Initial training shall include sufficient obedience training to perform an effective and controlled search.
   - 1.4 The canine shall be trained to perform an effective and controlled search off lead.
   - 1.5 The initial training of the canine shall include training of a determined specific response (active or passive alert).
   - 1.6 Initial training shall include odor for prescenting from a variety of objects typically expected in an operational setting, such as a handgun, tools, clothing, et cetera.
   - 1.7 The canine team's training shall be continued until a level of operational proficiency is achieved and the team is certified.
2. Canine Team Assessments
   - 2.1 Assessments are part of certification, maintenance training, and proficiency testing.
   - 2.2 Each assessment is the evaluation of a search.
   - 2.3 The canine team shall be assessed in the following ways:
     - 2.3.1 Odor recognition assessments consist of the canine making four runs on two scent line-ups. Each run is an

attempt to match an *odor sample* to its matching *line-up odor.* These are called *potential-match* runs.

2.3.1.1 Odor recognition assessments test the following:
  2.3.1.1.1 The ability of the canine to indicate matching human target odors in an array of different human distractor odors (line-up odors) after having been prescented on a target odor sample.
  2.3.1.1.2 The canine's response.
  2.3.1.1.3 The handler's interpretation of the canine's alert.

2.3.1.2 Preparation of line-up odor materials shall include the following steps:
  2.3.1.2.1 Odors from 12 different people shall be collected onto line-up odor materials prior to the assessment.
  2.3.1.2.2 The manner in which the material for the line-up is prepared shall be appropriate for the protocols of the agency and the training of the canine regarding material used to collect the scent, method, and duration of contact time with odor and temporary storage of the scent samples.

2.3.1.3 Preparation of prescenting materials shall include the following steps:
  2.3.1.3.1 The prescenting material from four different human targets shall be prepared prior to the assessment.
  2.3.1.3.2 The prescenting material shall be collected and stored in the manner appropriate for the training of the canine: either objects that have been in direct contact with the people, or scent pads prepared from such objects.
  2.3.1.3.3 At least four different kinds of objects for prescenting (with respect to type of material) shall be used. The testing agency may define a list of such objects, e.g., screwdrivers, crowbars,

hammers, gloves, caps. If prescenting is done on an object that has been in direct contact with a person, this object shall not be identical to the material used in the line-up.

2.3.1.3.4 The objects shall vary in duration of contact time with the human target and method of contact within limits set by the testing agency. Examples include: handling a screwdriver for 3 minutes, carrying a pair of gloves in a pocket for a day, and wearing a cap for an hour.

2.3.1.3.5 The prescenting material shall be prepared either directly after, or at least 24 hours prior to the preparation of the line-up odors in order to prevent the transfer of the object material odor onto the line-up odors.

2.3.1.4 Preparation of the line-ups.

2.3.1.4.1 Two six-position line-ups consisting of odors from 12 different people shall be prepared prior to the assessment, in a manner consistent with the training of the canine and agency protocol.

2.3.1.4.2 The two line-ups shall be conducted at such time that the line-up material has aged in a manner appropriate for the training of the canine.

2.3.1.5 Line-up protocol.

2.3.1.5.1 The handler shall inform the assessor of the canine's final response prior to the test.

2.3.1.5.2 For each line-up, the canine team shall perform two runs with different scent matches within a time frame that is consistent with the training of the canine and the protocols of the agency. For each run, the handler shall be provided with an appropriate prescenting material chosen by the assessor.

        2.3.1.5.3 The handler shall not know the position of the matching line-up odor in any run.
        2.3.1.5.4 The handler interprets the canine response and communicates this outcome to the assessor.
        2.3.1.5.5 In the event of a correct match, the matching line-up odor shall be removed from the line-up.
        2.3.1.5.6 The assessor shall know the position of the matching odor in each run.
        2.3.1.5.7 In a successful outcome of a potential-match run, the canine alerts to the matching line-up odor and does not alert to any of the distractor line-up odors.
        2.3.1.5.8 The handler shall be informed if a run has been successful immediately after its conclusion. This allows the handler to reward a correct outcome appropriately.
    2.3.1.6 Evaluation: the canine shall conduct 75% of the runs successfully.
2.3.2 Comprehensive assessment: should consist of six runs performed on three line-ups. In four potential-match runs, an attempt is made to match an odor sample to its matching line-up odor. In two *nonmatch* runs, the canine team has to conclude the *absence of a matching line-up odor* to the odor sample presented.
    2.3.2.1 The comprehensive assessment tests the following:
        2.3.2.1.1 The ability of the canine to indicate matching human target odors in an array of different human distractor odors (line-up odors) after having been prescented on a target odor sample in four potential-match runs.
        2.3.2.1.2 The ability of the canine team to conclude the absence of a matching human target odor in an array of different human distractor odors after having been prescented on a target odor sample in two nonmatch runs.

- 2.3.2.1.3 The canine's response.
- 2.3.2.1.4 The handler's interpretation of canine's response.
- 2.3.2.1.5 The canine team should be tested on six different human target odors in three, two run line-ups where each line-up contains different human distractor odors.

2.3.2.2 Preparation of line-up odor materials.

- 2.3.2.2.1 Odors from at least 18 different people shall be prepared prior to the assessment. These will be used in three line-ups.
- 2.3.2.2.2 The manner in which the material for the line-up is prepared shall be appropriate for the training level of the canine regarding the materials used to collect the scent, method, and duration of contact time with odor and temporary storage of the scent samples.

2.3.2.3 Preparation of prescenting materials.

- 2.3.2.3.1 The prescenting material from the same 18 different human targets and from at least two additional human targets shall be prepared prior to the assessment.
- 2.3.2.3.2 The prescenting materials shall be collected and stored in the manner appropriate for the training of the canine: either objects that have been in direct contact with the people, or scent pads prepared from such objects.
- 2.3.2.3.3 At least four different kinds of objects for prescenting (with respect to type of material) shall be used. The testing agency may define a list of such objects. If prescenting is done on an object that has been in direct contact with a person, this object shall not be identical to the material used in the line-up.
- 2.3.2.3.4 The objects shall vary in age, duration of contact time with the human

target, and method of contact within limits set by the testing agency.

2.3.2.3.5 The prescenting material shall be prepared either directly after, or at least 24 hours prior to the preparation of the line-up odors in order to prevent the transfer of object material odor onto the line-up odors.

2.3.2.4 Preparation of the line-ups.

2.3.2.4.1 Three six-position line-ups consisting of odors from 18 different people shall be prepared in a manner consistent with the training of the canine prior to the assessment.

2.3.2.4.2 The three line-ups shall be conducted at such a time that the line-up material has aged in a manner appropriate for the training of the canine.

2.3.2.5 Line-up protocol.

2.3.2.5.1 The handler shall inform the assessor of the canine's final response prior to the test.

2.3.2.5.2 For each line-up, the canine team shall perform two runs with different scent matches within a time frame that is consistent with the training of the canine and the protocols of the agency. For each run, the handler shall be provided with an appropriate prescenting material chosen by the assessor.

2.3.2.5.3 At least two runs chosen at random by the assessor shall be nonmatch runs and as such have no matching human target odor amidst the array of choices.

2.3.2.5.4 For potential-match runs, the handler shall be provided with an appropriate prescenting material chosen at random by the assessor.

2.3.2.5.5 For the nonmatch runs, the canine shall be prescented on material that does not have a matching line-up odor in any of the line-ups. This material is prescented by the additional human targets described in Section 2.3.2.3.

2.3.2.5.6 The handler shall not know the correct outcome of any run prior to the assessment.

2.3.2.5.7 The handler interprets the canine response and communicates this outcome to the assessor.

2.3.2.5.8 In the event of a correct match, the matching line-up odor shall be removed from the line-up.

2.3.2.5.9 The assessor shall know the position of the matching odor in each run.

2.3.2.5.10 A successful outcome of a potential-match run results when the canine alerts to the matching line-up odor and does not respond to any of the distractor line-up odors. This is called a correct positive.

2.3.2.5.11 A successful outcome of a nonmatch run results when the canine does not alert to any of the distractor line-up odors. This is called a correct negative.

2.3.2.5.12 The handler shall be informed if a run has been successful immediately after its conclusion. This allows the handler to reward the canine for a correct outcome appropriately.

2.3.2.6 Evaluation: The canine shall conduct 75% of the runs correctly, and not make a false alert (*false positive*) to any of the distractor line-up odors in any of the runs. A single nonalert (*miss*) is therefore permissible.

2.3.3 Double-blind assessment.

2.3.3.1 A double-blind assessment should consist of one or more line-ups conducted according to the team's usual protocol, including a realistic scent trace for prescenting the dog.

2.3.3.2 Preparation of line-up odor material.

2.3.3.2.1 The odors of the control target, the assessment suspect target, and the distractor targets shall be prepared prior to the line-up.

- 2.3.3.2.2 The manner in which the material for the line-up is prepared shall be appropriate for the training of the canine in terms of material used to collect the scent, method, and duration of contact time with odor, odor collection, and temporary storage of the scent samples.

2.3.3.3 Preparation of the prescenting material.

- 2.3.3.3.1 For the control runs in the line-up, the material for prescenting shall be prepared in accordance to the usual protocol.
- 2.3.3.3.2 For the realistic scent trace, the material for prescenting shall be prepared prior to preparation of the line-up material.
- 2.3.3.3.3 The odor samples for prescenting shall be collected and stored in the manner appropriate for the training of the canine: either objects that have been in direct contact with the people, or scent pads prepared from such objects.
- 2.3.3.3.4 The objects shall vary in age, duration of contact time with the human target, and method of contact to mimic operational variation.

2.3.3.4 Preparation of the line-ups.

- 2.3.3.4.1 The line-up shall be prepared in a manner consistent with the training of the canine.
- 2.3.3.4.2 The line-up shall be conducted at such time that the line-up material has aged in a manner appropriate for the training of the canine.

2.3.3.5 Line-up protocol.

- 2.3.3.5.1 The line-up shall be conducted according to the protocol determined by the agency for which the team is working.

2.3.3.6 Evaluation.

- 2.3.3.6.1 No one present in the room, including the dog and handler, shall know the correct outcome of the line-up.

2.3.3.6.2 At the conclusion of each assessment run, the handler may be notified immediately of the outcome in a manner that does not compromise the integrity of the double-blind test.

3. Canine Team Certification
   3.1 Certification for the named canine team shall be valid for one year.
      3.1.1 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.
      3.1.2 The certifying officials shall not be routinely involved in the day-to-day training of the canine team being evaluated.
      3.1.3 Handler errors, when excessive, may result in the failure of the team.
   3.2 Certification shall consist of a number of line-ups that together form the full test.
      3.2.1 Human odors (both target and distractor) used in the day-to-day training of the team being certified shall not be used in the certification process.
      3.2.2 Line-up material and material used for prescenting the canine shall not have been used for another dog prior to being used in certification.
      3.2.3 The certification shall be comprised of a comprehensive assessment which incorporates odor recognition to such an extent that a separate odor recognition test is not necessary. The comprehensive assessment may be combined with a double-blind assessment.
   3.3 A canine team that fails the certification process shall complete a corrective action plan before making another attempt to certify.
4. Maintenance Training
   4.1 The canine team shall conduct regular objective-oriented training sufficient to maintain and enhance operational proficiency. Maintenance training shall include the following:
      4.1.1 A variety of objects (varying shapes, sizes, manner, and duration of contact, weights, materials, etc.) used for prescenting, or for the collection of scent for prescenting.
      4.1.2 A variety of human targets and distractors.

    - 4.1.3 A variety of durations of set times and environmental conditions during this set time for the objects used for prescenting.
    - 4.1.4 A varied duration of storage of objects used for prescenting.
  - 4.2 Training conducted solely by the handler to maintain the canine's proficiency is acceptable, but should be regularly combined with assisted training in order to conduct single-blind training exercises.
  - 4.3 Supervised training should be conducted periodically.
    - 4.3.1 Supervised training, by a qualified trainer or instructor, is recommended in order to monitor and improve performance, identify and correct training deficiencies, and to perform proficiency assessments.
  - 4.4 Scent identification training shall be conducted at least 16 hours per month to maintain and improve the proficiency level of the team. Training should be distributed evenly throughout the month.
  - 4.5 The canine team shall undergo periodic proficiency assessments as outlined in Section 2—the "Canine Team Assessments." These assessments should include a variety of odor recognition assessments, comprehensive assessments, and double-blind assessments.
- 5. Records and Document Management
  - 5.1 The handler and department or organization shall document training, certification, proficiency assessments, and deployment data.
    - 5.1.1 Training and proficiency assessment records may be combined or maintained separately.
    - 5.1.2 Deployment records shall be maintained separately from training, certification, and proficiency assessment records.
    - 5.1.3 Training records should be standardized within the department or organization.
  - 5.2 Training records may include, but are not limited to, the following data:
    - 5.2.1 Name of handler and canine.
    - 5.2.2 Names of individuals conducting or assisting with the training.
    - 5.2.3 Time and date training took place.
    - 5.2.4 Location and environmental conditions.
    - 5.2.5 Training design (nonblind, single-blind, or double-blind).
    - 5.2.6 Names or descriptions of individuals contributing odor to the line-up.

  - 5.2.7 Detailed descriptions of articles used for prescenting (duration of contact, method of preparation and storage, type of article, etc.).
  - 5.2.8 Results.
  - 5.2.9 Deficiencies and corrective measures implemented.
- 5.3 Certification records shall be maintained by the certifying authority and the handler and include the following information:
  - 5.3.1 Name of handler and canine.
  - 5.3.2 Date team certified.
  - 5.3.3 Certification authority, that is, agency, professional organization, or individuals.
  - 5.3.4 The standard or guideline under which the canine team is certified.
  - 5.3.5 Names of individuals awarding certification.
  - 5.3.6 Location of certification.
  - 5.3.7 A complete description of certification tests in accordance with Section 2.
- 5.4 Proficiency assessment records maintained by the handler and department or organization may include, but are not limited to, the following data:
  - 5.4.1 Name of handler and canine.
  - 5.4.2 Names of individuals conducting assessment.
  - 5.4.3 Time and date assessment took place.
  - 5.4.4 Location and environmental conditions.
  - 5.4.5 Assessment design (single-blind or double-blind).
  - 5.4.6 Names of individuals contributing odor to the line-up.
  - 5.4.7 Detailed description of the article used for prescenting (duration of contact and method of preparation and storage, type of article, etc).
  - 5.4.8 Results.
- 5.5 Supervisory review of all records is recommended.
- 5.6 Digitally formatted records are recommended to facilitate compiling and analyzing data.
- 5.7 Records may be discoverable in court proceedings and may become evidence of the canine team’s reliability. Record retention policy shall be determined by department or organization guidelines.
- 5.8 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
- 5.9 Confirmed operational outcomes can be used as a factor in determining capability.

5.10 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine team's proficiency.

5.11 Veterinary records.
  - 5.11.1 Veterinary records shall be maintained in a manner such as they are accessible to the handler/department/organization.
  - 5.11.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

SWGDOG SC9—Human Scent Dogs

Searching for Live People in Disaster Environments

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Searching for live people in disaster environments utilizes the canine to search for, detect, and/or locate live people in debris resulting from both man-made and natural catastrophic events.

Statement of Purpose: To provide recommended guidelines for training, certification, and documentation pertaining to canine teams trained to search for live people in disaster environments, including structural collapse.

1. Initial Training
  - 1.1 The handler training shall be conducted by a competent trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.
  - 1.2 Handler training shall include the following topics:
    - 1.2.1 Search techniques and tactics.
    - 1.2.2 Proper use of personal protective equipment (PPE).
    - 1.2.3 Environmental conditions affecting odor dispersion in order to enable the handler to maximize search efficiency.
    - 1.2.4 First aid for the canine team and the subject or victim.
    - 1.2.5 Pertinent National Incident Management System (NIMS) classes (i.e., ICS 100, ICS 200, and IS 700 and any applicable updates), which can be taken online.
    - 1.2.6 Structural collapse awareness training.
    - 1.2.7 Confined space awareness training.
    - 1.2.8 Hazardous materials (HazMat) awareness training.
  - 1.3 The canine training shall be conducted by a competent canine trainer from an entity that utilizes a structured curriculum with specific training and learning objectives.

- 1.4 Initial training shall include sufficient obedience training to ensure the canine will operate effectively based on mission requirements.
- 1.5 Initial training shall include a behavioral assessment of the canine in search and rescue applications to dismiss canines prone to unprovoked attacks on humans or animals.
- 1.6 The canine shall be trained to perform an effective and controlled search.
- 1.7 The initial training of the canine shall include training of a determined specific final response (bark).
- 1.8 Initial training shall include exposing the canine team to a variety of disaster locations, expected situations, and a variety of distractors that may include human remains, animals, noise, and human-scented articles.
- 1.9 The training shall be structured to meet the typical mission requirements of the canine team's department or organization.
- 1.10 The canine team's training shall be continued until a level of operational proficiency is achieved and the team is certified.

2. Canine Team Assessments
    - 2.1 Assessments are part of certification, maintenance training, and proficiency testing.
    - 2.2 Each assessment is the evaluation of a search.
    - 2.3 The canine team shall be assessed using an odor recognition assessment, a comprehensive assessment, and a double-blind assessment.
    - 2.4 Odor recognition assessment tests the following:
        - 2.4.1 The ability of the canine to locate and bark to indicate the presence of a concealed live human in a controlled setting.
        - 2.4.2 The canine's ability to remain at the victim location and to exhibit a focused bark response/indication for 30 seconds (a minimum of six barks may be interspersed with digging and attempts to penetrate) without handler influence.
    - 2.5 An odor recognition assessment shall be set up as follows:
        - 2.5.1 An area containing a minimum of five props shall be set up in a controlled setting.
        - 2.5.2 The props should be made or constructed of materials that give the optimum control of scent (e.g., barrels, concrete sewer pipe). The props need to be constructed to prevent canine penetration and shall include:
            - 2.5.2.1 One blank prop.

2.5.2.2 Two props with distractions, for example, food, clothing, an animal.

2.5.2.3 One prop with a live person.

2.5.3 The victim and all distractors will be placed at least 10 minutes before the start of the assessment.

2.5.4 The starting point shall be measured and clearly marked.

2.5.5 This distance shall be approximately 23 meters (25 yd.) from the starting point to the first prop.

2.5.6 The handler shall have a clear line of sight of the canine in the prop area.

2.5.7 The handler shall remove the canine's leash before the exercise begins.

2.5.8 The handler shall not move from the starting point.

2.5.9 The team shall have 5 minutes to complete the exercise.

2.5.10 The successful outcome shall be the canine locating and barking at the concealed live person.

2.5.11 No false alerts are permitted.

2.6 A comprehensive assessment tests the following:

2.6.1 The ability of the canine team to find concealed live humans on limited-access and full-access disaster sites.

2.7 A comprehensive assessment shall be set up as follows:

2.7.1 Two separate search sites shall be prepared. They shall be separated by a minimum of 6 meters (≈ 20 ft.). One of these search sites shall be used as a handler limited-access site, the other as a handler full-access site.

2.7.2 When conducting concurrent testing, the search sites shall be visually separated.

2.7.3 Each search site shall be a rubble pile, which consists of a partially or completely collapsed structure with an area approximately 600–1400 m^2 (10,000–15,000 sq. ft.). The composition of the rubble piles shall consist of concrete, wood, and miscellaneous mixed materials.

2.7.4 The limited-access site shall have a minimum average height or depth of 2 meters (≈6 ft.).

2.7.5 The full-access site has no height or depth requirement.

2.7.6 Each search site shall contain enough hiding locations to accommodate potential false holes, up to four victims, and a maximum of three distractions.

2.7.7 The limited-access site starting point shall be located where the handler has limited view of the search site. The victims shall be placed in such a way that the handler cannot see the dog locate the first victim.

2.7.8 The starting point for the full-access site shall be determined by the canine handler.

2.7.9 Barriers or banner tape can be used to identify search or unsafe areas.

2.7.10 Certifying agencies shall ensure proper site safety measures.

2.7.11 The victims shall be placed as follows:

  2.7.11.1 A total of four to six victims shall be placed at least 20 minutes before the evaluation begins.

  2.7.11.2 Zero to four victims shall be placed in the full access search site.

  2.7.11.3 One to four victims shall be placed in the limited access search site.

  2.7.11.4 The victims shall be separated by a minimum of 6 meters (≈ 20 ft.).

  2.7.11.5 All victims shall be concealed from both handler and canine.

  2.7.11.6 The hiding areas for the fully concealed victims should be constructed to prevent canines from accessing the victim.

  2.7.11.7 After every three assessments, at least one victim should be relocated to another hiding area.

2.7.12 One or more search sites shall be contaminated with distractors:

  2.7.12.1 The scent distractors should be placed to enable the evaluators to determine if the dog is alerting to the distractor or live human scent.

  2.7.12.2 The placed-scent distractors shall include clothes and food.

  2.7.12.3 The placed-scent distractors may include animals (dead or alive/caged).

  2.7.12.4 The placed-scent distractors shall be hidden and inaccessible to the canine.

  2.7.12.5 There should be noise distractions such as running generators, machinery, rescue tools, and so on. Noise distractions may be supplied by audiotapes.

2.7.13 Proofing/verification of the certification area shall be conducted prior to the actual certification using a certified canine team who is not participating in the certification. This team shall be available throughout the certification to proof victims when they are relocated.

2.7.14 Search procedures:

2.7.14.1 The team shall have 20 minutes to search each site. This includes the canine indicating live human scent and the handler identifying the area of the canine's alert.

2.7.14.2 Full-access search site procedures include the following:

- 2.7.14.2.1 The site shall be completely accessible to the handler.
- 2.7.14.2.2 The handler may access the site from any point.
- 2.7.14.2.3 The response of the team shall consist of the canine barking a minimum of three times at the same victim and the handler interpreting the canine's alert.
- 2.7.14.2.4 The handler shall mark the area identified by the canine's alert as specified by the certifying agency. Once a response/indication is marked, it is final.
- 2.7.14.2.5 If between the first and third bark, a handler verbally communicates with his dog in order to keep him barking at a victim, the find shall be considered a miss.
- 2.7.14.2.6 Barking may be interspersed with digging, scratching, or any other attempt to get to the victim.
- 2.7.14.2.7 The canine may reposition itself while alerting to the victim location.
- 2.7.14.2.8 If the canine leaves the victim location before barking three times, the indication process (three bark requirement) starts over.

2.7.14.3 Limited-access search site procedures include the following:

- 2.7.14.3.1 The site shall provide access to only one well-marked portion of the perimeter.
- 2.7.14.3.2 The canine shall initially search out of the handler's sight in order to locate the first victim.
- 2.7.14.3.3 The handler shall access the site to mark the response/indication location and restart the canine.

- 2.7.14.3.4 The handler shall remain within a 5-foot radius of the prior response/indication location or return to the starting point (as directed by the evaluator) while the canine continues to search for victims.
- 2.7.14.3.5 If the handler returns to the starting point, he or she may not access the site until the dog alerts again.

2.7.15 Successful completion of the assessment includes the following:

- 2.7.15.1 A 75% positive alert rate, which includes a minimum of one find on the limited-access site.
- 2.7.15.2 No false alerts. It is the handler's responsibility to report when the canine has alerted.
- 2.7.15.3 The handler's demonstration of the ability to maintain control of their canine.

2.8 Double-blind assessments shall only be conducted in situations where safety is not an issue, such as odor recognition assessments.

3. Canine Team Certification

3.1 Certification for the named canine team shall consist of a comprehensive assessment every three years. This shall be complemented with periodic proficiency assessments throughout the year.

- 3.1.1 Certification does not relieve the canine team from regular maintenance training, proficiency assessments, and following other recommended SWGDOG guidelines.
- 3.1.2 The certifying officials should not be routinely involved in the day-to-day training of the canine team being evaluated.
- 3.1.3 Specific assessment criteria are articulated by each discipline.
- 3.1.4 Handler errors, when excessive, may result in failure of the team.
- 3.1.5 A mission-oriented test environment shall be used.

3.2 Certification shall consist of a number of assessments that together form the full test.

- 3.2.1 Each assessment is the evaluation of a search.
- 3.2.2 Targets used in the day-to-day training activities of the team being certified shall not be used in the certification process.
- 3.2.3 The certification shall be comprised of a comprehensive assessment together with either an odor recognition assessment or a double-blind assessment, or both.

- 3.3 For successful certification, the canine team shall achieve at least a 75% positive alert rate, and no false alerts. It is the handler's responsibility to report when the canine has alerted.
- 3.4 A canine team that fails the certification shall complete a corrective action plan before making another attempt to certify.

4. Maintenance Training
    - 4.1 The canine team shall conduct regular objective-oriented training sufficient to maintain and enhance operational proficiency. Maintenance training shall include the following:
        - 4.1.1 Correcting identified deficiencies or operational concerns.
        - 4.1.2 A variety of search locations, location sizes, and environmental conditions.
        - 4.1.3 Varied durations of search times.
        - 4.1.4 Varied times of day/night.
        - 4.1.5 A variety of blank searches.
        - 4.1.6 A variety of distractors in the search area that may include human remains, animals, noise, and human-scented articles.
        - 4.1.7 A variety of set times.
        - 4.1.8 A variety of targets and number of targets where applicable.
        - 4.1.9 A variety of methods of concealment.
    - 4.2 Training conducted solely by the handler to maintain the canine's proficiency is acceptable, but should be periodically combined with supervised training.
        - 4.2.1 Supervised training, by a competent trainer or instructor, is recommended in order to monitor and improve performance, identify and correct training deficiencies, and perform proficiency assessments.
    - 4.3 A canine team shall complete a minimum of 16 hours of training per month to maintain and improve the proficiency level of the team.
    - 4.4 The canine team shall undergo periodic proficiency assessments as outlined in Section 2—the "Canine Team Assessments." These assessments should include a variety of odor recognition assessments, comprehensive assessments, and/or double-blind assessments.
5. Record Keeping and Document Management
    - 5.1 The handler/department or organization shall document training, certification, proficiency assessments, and discipline-related deployment data.
        - 5.1.1 Training and proficiency assessment records may be combined or maintained separately.

- 5.1.2 Discipline-related deployment records shall be maintained separately from training, certification, and proficiency assessment records.
- 5.1.3 Training and discipline-related records should be standardized within the department or organization.

5.2 Training records may include but are not limited to the following data:

- 5.2.1 Name of handler and canine.
- 5.2.2 Names of individuals conducting or assisting with training.
- 5.2.3 Time and date training took place.
- 5.2.4 Location and environmental conditions of training.
- 5.2.5 Training design (nonblind, single-blind, or double-blind).
- 5.2.6 Description and number of targets.
- 5.2.7 Location of targets.
- 5.2.8 Set time.
- 5.2.9 Size of search area.
- 5.2.10 Length of session.
- 5.2.11 Search results.
- 5.2.12 Deficiencies and corrective measures implemented.
- 5.2.13 Other information required by department or organization.

5.3 Certification records shall be maintained by the certifying authority and the handler, and include the following information:

- 5.3.1 Name of canine and handler.
- 5.3.2 Date team certified.
- 5.3.3 Certification authority, that is, agency, professional organization, or individuals. The standard or guideline under which the canine team is certified.
- 5.3.4 Name of individuals awarding certification.
- 5.3.5 Location of certification.
- 5.3.6 Search area types included in certification assessment.
- 5.3.7 Description and number of targets and distractors used in the certification assessment.
- 5.3.8 Set time.

5.4 Proficiency assessment records maintained by the handler and department or organization may include, but are not limited to, the following data:

- 5.4.1 Name of handler and canine.
- 5.4.2 Names of individuals conducting assessment.
- 5.4.3 Time and date assessment took place.
- 5.4.4 Location and environmental conditions.
- 5.4.5 Assessment design (single-blind or double-blind).
- 5.4.6 Search area types included in proficiency assessment.

    - 5.4.7 Description and number of targets.
    - 5.4.8 Location of targets.
    - 5.4.9 Set time.
    - 5.4.10 Size of search area.
    - 5.4.11 Proficiency assessment results.
    - 5.4.12 Other information required by department or organization.
- 5.5 Supervisory review of all records is recommended.
- 5.6 Digitally formatted records are recommended to facilitate compiling and analyzing data.
- 5.7 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by the canine team's department or organization guidelines.
- 5.8 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
- 5.9 Confirmed operational outcomes can be used as a factor in determining capability.
- 5.10 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine team's proficiency (i.e., residual odor can be present or concealment may preclude discovery).
- 5.11 Veterinary records.
    - 5.11.1 Veterinary records shall be maintained in a manner that allows accessibility by the handler, department, and organization.
    - 5.11.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

SWGDOG SC9—Human Scent Dogs

Tracking/Trailing People Based on Last Known Position

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Tracking or trailing people based on their last known position is the area of canine scent detection that utilizes a canine team to search for and follow a specific person's track or trail after the canine has been started on the person's last known position or a scented article associated with that person. The primary goal is for the canine to detect and follow the track or trail to the exclusion of all other tracks or trails, leading to a specific person, location, and/or article associated with that person. This is done within the canine team's mission-specific environment. A secondary goal of this task may be to locate articles left by this specific person along the track or trail.

Statement of Purpose: To provide recommended guidelines for the training, certification, and documentation pertaining to canines trained to search for a specific person, location, and/or article by starting from that person's last known position.

1. Initial Training
    - 1.1 To achieve search functionality, the handler shall be trained by a competent individual who utilizes a structured curriculum with specific training and learning objectives.
    - 1.2 Handler training shall include human scent theory, relevant canine case law, and legal preparation, including court testimony.
    - 1.3 Training of the handler shall include recognition and articulation of the canine's (change of) behavior during the search and the specific final response.
    - 1.4 Handler training may include techniques for collecting, handling, storing, and disposing of articles and human scent evidence as required by the handler's department or organization.
    - 1.5 In order to maximize search efficiency, handler training shall include learning search techniques and tactics, as well as the principals of odor dispersion and how dispersion is affected by environmental conditions.
    - 1.6 Training shall include exposing the canine to a variety of different types of locations, noises, odors, people, and environments.
    - 1.7 Initial training shall include sufficient obedience training to ensure the canine will operate effectively based on mission requirements.
    - 1.8 The canine shall be trained to perform a predetermined specific final response (active or passive alert) upon locating the human target.
    - 1.9 If article location is required, the canine shall be trained to leave the articles undisturbed.
    - 1.10 To achieve search functionality, the canine team shall be trained by a competent trainer utilizing a structured curriculum with specific training and learning objectives.
    - 1.11 The canine team's training shall be continued until a level of operational proficiency is achieved and the team is certified.
    - 1.12 The training shall be structured to meet the typical mission requirements of the canine team's department or organization.

2. Canine Team Assessments
   - 2.1 Assessments are part of certification, maintenance, and proficiency testing.
   - 2.2 Each assessment is the evaluation of a search.
   - 2.3 The canine team shall be assessed in the following ways:
     - 2.3.1 Odor recognition assessments that test the following:
       - 2.3.1.1 The canine's ability to follow a simple human track or trail containing a minimum of one turn and a distractor track or trail.
       - 2.3.1.2 The handler's interpretation of the canine's behavior on the track or trail.
       - 2.3.1.3 Each canine team shall work on a separate track or trail.
       - 2.3.1.4 For an odor recognition assessment, one human target and one or two human distractors (depending on the track or trail design, see point 4.1.1. below) are utilized to lay human tracks or trails in an environment similar to where the canine usually works (e.g., urban, suburban, or rural environments).
       - 2.3.1.5 An odor recognition assessment track or trail shall consist of either one of two track or trail designs: a cross-over design or a split turn design.*

         These shall consist of one human target track or trail and one (cross-over) or two (split turn)

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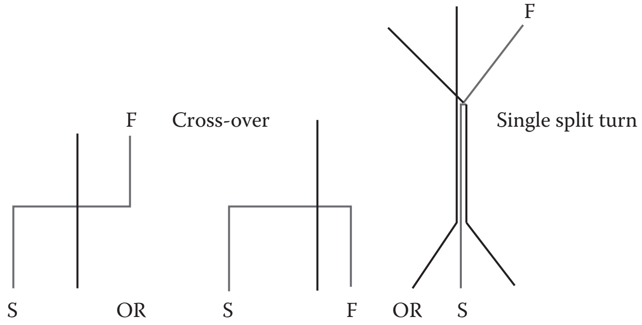
* Track or trail designs: examples of cross-over and single split turn: S is starting point for the human target, F is finishing point (or the mirror images). In a cross-over design, the target makes two turns and his track or trail is crossed once by a distractor fresher track or trail. In the split turn design, the target track or trail joins two separate distractor tracks or trails: one fresher, one the same age. After a common part, the tracks or trails split up and the target makes a turn.



human distractor tracks or trails, positioned within a minimum of 185 meters (≈200 yd.) from each other. Of the 185 meters minimum, 90 meters (≈100 yd.) must be track or trail odor identification.

2.3.1.6 The target track or trail of the cross-over track shall be aged a minimum of 1 hour and the distractor a maximum of 30 minutes.

2.3.1.7 The target track or trail and one of the split turn human distractor trails shall be aged a minimum of 1 hour and the other distractor track or trail shall be aged a maximum of 30 minutes.

2.3.1.8 Prior to the test, the start of the track or trail shall be marked by the assessing agency.

2.3.1.9 The handler shall be directed to the start marker, but not given the target's direction of travel.

2.3.1.10 The assessor shall know the correct outcome of the assessment.

2.3.1.11 The handler shall not know the correct outcome of the assessment.

2.3.1.12 A successful completion of the odor recognition assessment is the ability to determine the correct direction of travel and follow the track or trail beyond the turns to its completion.

2.3.1.13 The assessor shall take into consideration environmental influences on odor dispersion in determining whether or not the canine team has successfully completed the odor recognition assessment.

2.3.2 Comprehensive assessments shall test the following:

2.3.2.1 The ability of the canine team to follow a track or trail on different surfaces and identify a specific person, location, or article, as required by the organization or agency.

2.3.2.2 The handler's ability to interpret the canine's behavior, including the final response.

2.3.2.3 The canine's responses.

2.3.2.4 Each canine team shall work on a separate track or trail.

2.3.2.5 A mission-oriented assessment environment shall be used.

2.3.3 Parameters of the assessment may vary based upon mission requirements.
  2.3.3.1 Rural environment parameters include a track or trail that is a minimum of 730 meters (≈800 yd.) in length, a minimum of 4 turns, at least 2 surface changes and a minimum set time of 30 minutes.
  2.3.3.2 Urban environment parameters include a track or trail that is a minimum of 275 meters (≈300 yd.) in length, a minimum of 3 turns, at least 2 surface changes, and a minimum set time of 30 minutes.
  2.3.3.3 The target may leave personally scented articles along the track or trail.
  2.3.3.4 If the assessment location does not contain normally occurring distractors, such as human and animal activity, distractors should be placed along the track or trail.
  2.3.3.5 The assessment area shall contain other human tracks or trails (fresher than the target trail) occurring both intermittently across and along a section of the target track or trail.
  2.3.3.6 The assessment location shall not be an area regularly used for the training of the team.
  2.3.3.7 The handler shall be informed of the start location.
  2.3.3.8 The assessment shall be completed in less than 30 minutes.
  2.3.3.9 The assessor shall know the correct layout of the track or trail.
  2.3.3.10 The handler shall not know the correct layout of the track or trail.
  2.3.3.11 If required during the assessment, the handler shall identify the presence of articles along the track or trail based on the canine's behavior.
  2.3.3.12 The parameters of a successful conclusion of the assessment shall be defined by organization or agency protocol. Examples of such parameters may include the following:
    2.3.3.12.1 Maximum allowable distance off track.
    2.3.3.12.2 Acceptable alert(s).
    2.3.3.12.3 Number of articles to be located.

        - 2.3.3.13 The assessor shall take into consideration environmental influences on odor dispersion in determining whether or not a canine team is still on the track or trail.
        - 2.3.3.14 Identifying a human distracter or following a distracter odor track or trail will be considered a failure.
    - 2.3.4 Double-blind assessments demonstrate the proficiency of the canine handler team in an operational setting.
        - 2.3.4.1 The handler will be advised of the start location.
        - 2.3.4.2 The handler shall not know the location of the end point, nor the number of turns.
        - 2.3.4.3 The canine team shall be required to successfully complete the assessment as defined by the assessing agency.
        - 2.3.4.4 Identifying a human distracter or following a distracter odor track or trail will be considered a failure.
        - 2.3.4.5 No participant or observer present at the assessment locations shall be aware of the desired outcome of the search.
        - 2.3.4.6 The assessor shall observe the canine team. At the conclusion of the assessment, the assessor shall compare the search results with the parameters of the search. This comparison may be done immediately after the handler determines the canine has made its trained response, or at the conclusion of the entire assessment.

3. Canine Team Certification
    - 3.1 Certification for the named canine team shall be valid for one year.
    - 3.2 Certification does not relieve the canine team from regular maintenance training, periodic proficiency assessments, and following other recommended SWGDOG guidelines.
    - 3.3 The certifying officials shall not be routinely involved in the day-to-day training of the canine team being evaluated.
    - 3.4 Handler errors, when excessive, may result in failure of the team.
    - 3.5 A mission-oriented test environment shall be used.
        - 3.5.1 Parameters of the assessment may vary based upon mission requirements.
            - 3.5.1.1 Rural environment parameters include a track or trail that is a minimum of 730 meters

(≈800 yd.) in length, a minimum of 4 turns, at least 2 surface changes and a minimum set time of 30 minutes.

3.5.1.2 Urban environment parameters include a track or trail that is a minimum of 275 meters (≈300 yd.) in length, a minimum of 3 turns, at least 2 surface changes and a minimum set time of 30 minutes.

3.6 Human targets used in the certification process shall not have been used in the day-to-day training activities of the team being certified.

3.7 A canine team which fails the certification process shall complete a corrective action plan before making another attempt to certify.

4. Maintenance Training

4.1 The canine team shall conduct regular objective-oriented training sufficient to maintain operational proficiency.

4.2 Training is meant to sustain, enhance, and promote the performance of the canine team.

4.3 Canine teams shall be challenged during the regular maintenance training sessions within the operational environments for which the team may be deployed.

4.3.1 Training shall include:

4.3.1.1 A variety of locations, terrain, search area sizes, and weather conditions.

4.3.1.2 A variety of distraction odors in the search area.

4.3.1.3 A variety of articles (various shapes, sizes, manner, and duration of contact, weights, materials, etc.) if required by the agency/organization.

4.3.1.4 A varied duration of search times and times of day.

4.3.1.5 A variety of blank search areas.

4.3.1.6 A variety of set times of target track or trails, articles, and degrees of concealment.

4.3.1.7 A variety of human targets.

4.4 Routine training conducted solely by the handler to maintain the canine's proficiency is acceptable but should be periodically combined with supervised training.

4.4.1 Supervised training by a qualified trainer or instructor is recommended in order to monitor and improve performance, identify, and correct training deficiencies and perform proficiency assessments.

- 4.5 Tracking/trailing training shall be included in the minimum of 16 hours of training per month to maintain and improve the proficiency level of the canine team.
- 4.6 The canine team shall perform periodic proficiency assessments throughout the certification period as outlined in Section 2—"Canine Team Assessments," including a variety of odor recognition assessments, comprehensive assessments, and double-blind assessments.

5. Record Keeping and Document Management
   - 5.1 The handler and department or organization shall document training, certification, proficiency assessments, and discipline-related deployment records.
   - 5.2 Proficiency assessments and training records may be combined or separate documents.
   - 5.3 Discipline-related deployment records shall be separated from training, proficiency assessment, and certification documentation.
   - 5.4 Training and discipline-related records should be standardized within the department or organization.
   - 5.5 Training records may include, but are not limited to the following data:
     - 5.5.1 Name of handler and canine.
     - 5.5.2 Names of individual conducting or assisting with training.
     - 5.5.3 Time and date of training.
     - 5.5.4 Location and environmental conditions of training.
     - 5.5.5 Training design (nonblind, single-blind, or double-blind).
     - 5.5.6 Description of targets.
     - 5.5.7 Location of targets.
     - 5.5.8 Set time.
     - 5.5.9 Size of search area.
     - 5.5.10 Length of training session.
     - 5.5.11 Search results.
     - 5.5.12 Deficiencies and corrective measures implemented during training regimen.
     - 5.5.13 Other information required by department or organization.
   - 5.6 Certification records shall be kept by the certifying authority and the handler and include the following information:
     - 5.6.1 Name of canine and handler.
     - 5.6.2 Date team certified.
     - 5.6.3 Certification authority, that is, agency, professional organization, or individuals.

   - 5.6.4 The standard or guideline to which the canine team is certified.
   - 5.6.5 Name of individuals awarding certification.
   - 5.6.6 Search area types included in certification assessment.
   - 5.6.7 Name and description of targets and locations included in certification assessment.
   - 5.6.8 Location of certification.
- 5.7 Proficiency assessment records kept by the handler and organization or department may include but not be limited to the following data:
   - 5.7.1 Name of handler and canine.
   - 5.7.2 Name of individual conducting assessment.
   - 5.7.3 Time and date of assessment.
   - 5.7.4 Location and environmental conditions of assessment.
   - 5.7.5 Assessment design (single-blind or double-blind).
   - 5.7.6 Description of targets.
   - 5.7.7 Location of targets.
   - 5.7.8 Set time.
   - 5.7.9 Size of search area.
   - 5.7.10 Proficiency assessment results.
   - 5.7.11 Other information required by department or organization.
- 5.8 Supervisory review of all records is recommended.
- 5.9 Digitally formatted records are recommended to facilitate compiling and analyzing data.
- 5.10 Records may be discoverable in court proceedings and may become evidence of the canine team's reliability. Record retention policy shall be determined by department or organization guidelines.
- 5.11 Training records are necessary to illustrate the type and amount of training that the team has experienced before and after certification.
- 5.12 Confirmed operational outcomes can be used as a factor in determining capability.
- 5.13 Unconfirmed operational outcomes shall not be used as a factor in determining capability in that they do not correctly evaluate a canine/handler team's proficiency.
- 5.14 Veterinary records.
   - 5.14.1 Veterinary records shall be maintained in a manner such as they are accessible to the handler and department or organization.
   - 5.14.2 Vaccinations required by state or local law should be documented in the veterinary record of the canine.

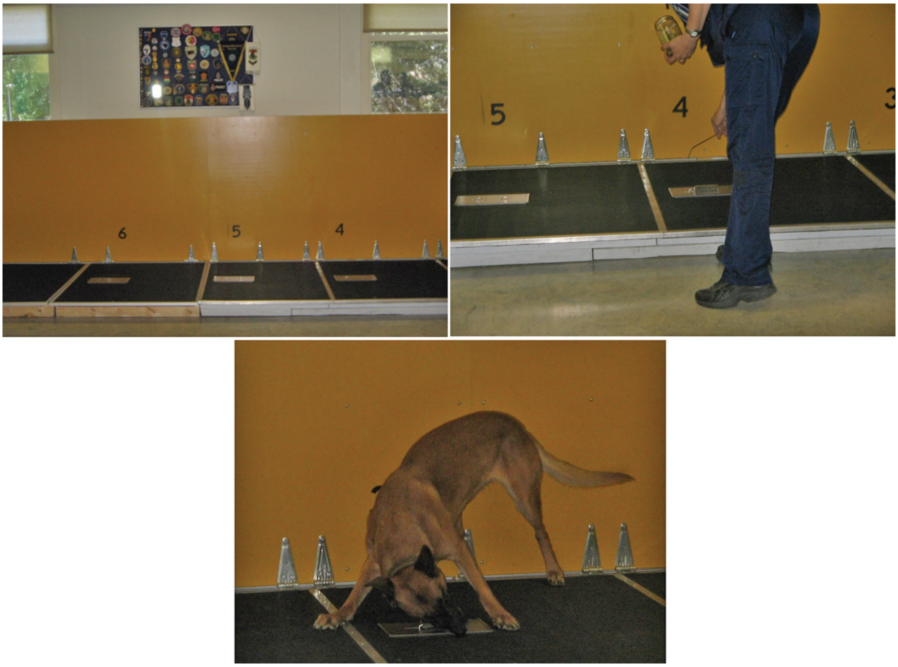


Figure 1.3 Scent line-up identifications as conducted in Finland. (Photos courtesy of Paola A. Prada, Police Dog Training Center, Hämeenlinna, Finland, June 2006.)

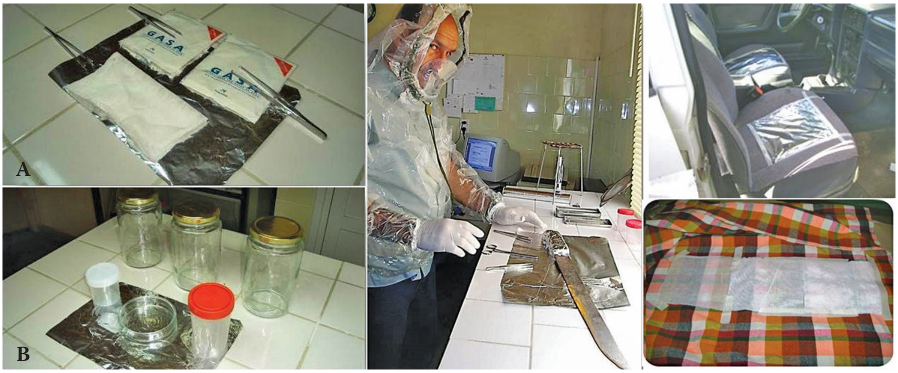


Figure 1.4 Scent collection in Argentina: (A) cloth (gauze) material, (B) glass jars for storage. Scent collection from (C) knife, (D) car seat, (E) bed linens. (Photos courtesy of Dr. Mario R. Rosillo.)

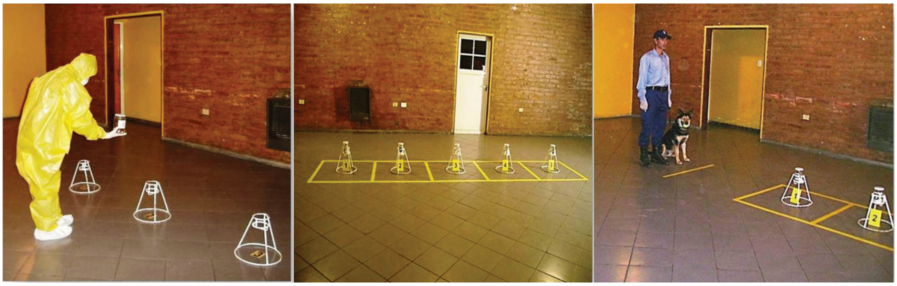


Figure 1.5 Current scent identification line-up in the facilities at the canine unit in Rio Negro, Argentina. (Photos courtesy of Dr. Mario R. Rosillo.)

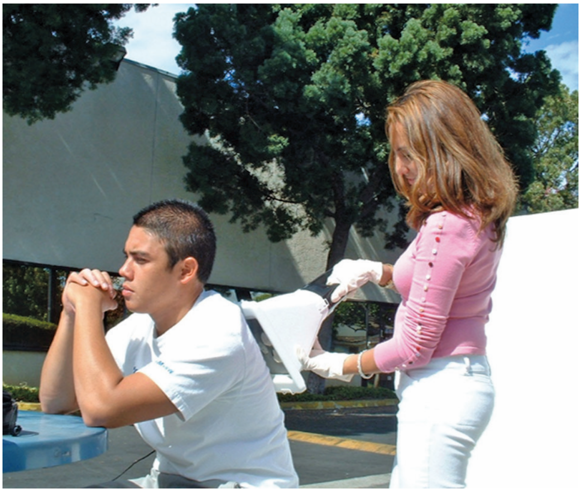


Figure 1.7 Scent pad creation via the STU-100. (Photo courtesy of Paola A. Prada.)

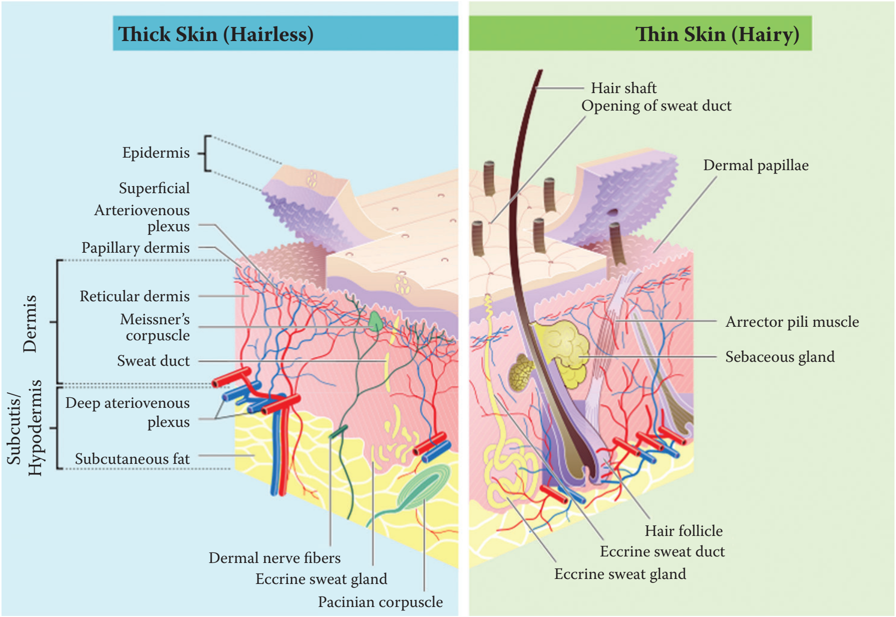

Thick Skin (Hairless)
Thin Skin (Hairy)
Epidermis
Superficial Arteriovenous plexus
Papillary dermis
Dermis
Reticular dermis
Meissner's corpuscle
Sweat duct
Subcutis/ Hypodermis
Deep ateriovenous plexus
Subcutaneous fat
Dermal nerve fibers
Eccrine sweat gland
Pacinian corpuscle
Hair shaft
Opening of sweat duct
Dermal papillae
Arrector pili muscle
Sebaceous gland
Hair follicle
Eccrine sweat duct
Eccrine sweat gland

Figure 2.2 Schematic of human skin composition. (From "Skin." Wikipedia: The Free Encyclopedia, Wikimedia Foundation, Inc. May 7, 2014. Available at https://en.wikipedia.org/wiki/File:Skin_layers.png, accessed November 6, 2013.)

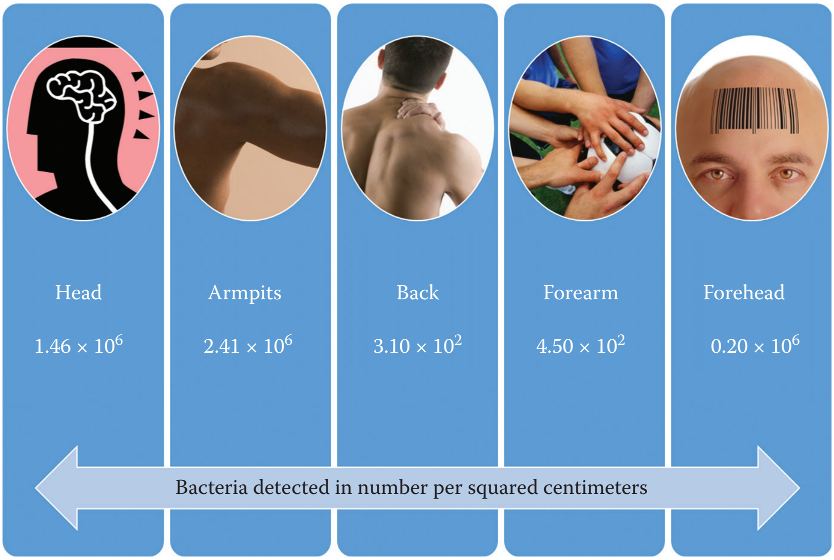


Figure 2.4 Number of skin microbiota as a function of body region. (Data adapted from Yamazaki S., Hoshino K., Kusuhara M., 2010, Odor Associated with Aging, *Anti-Aging Medicine*, 7, 60–65.[30])

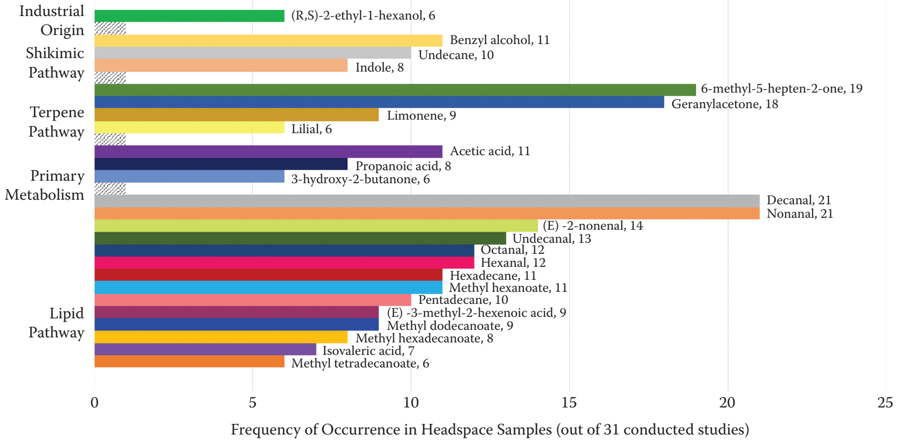


Figure 3.1 The 25 most frequently isolated compounds in headspace odor samples. (Data adapted from Dormont L. et al., 2013, Human Skin Volatiles: A Review, *Journal of Chemical Ecology*, 39, 569–578.[9])

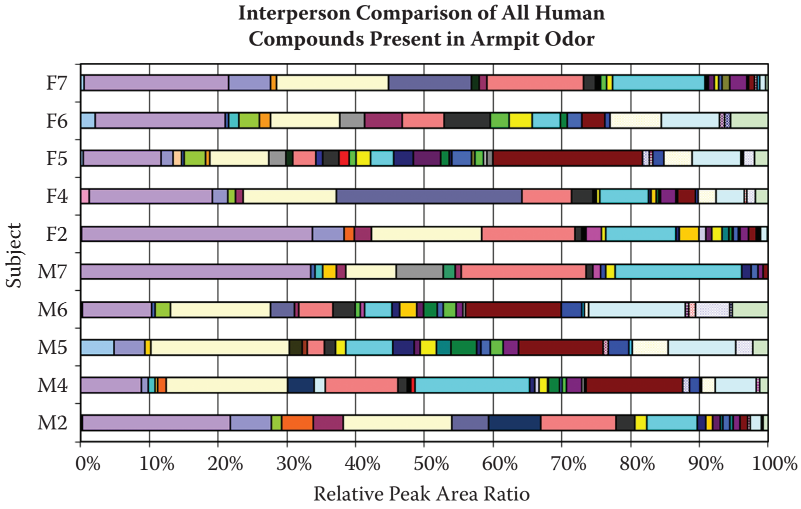
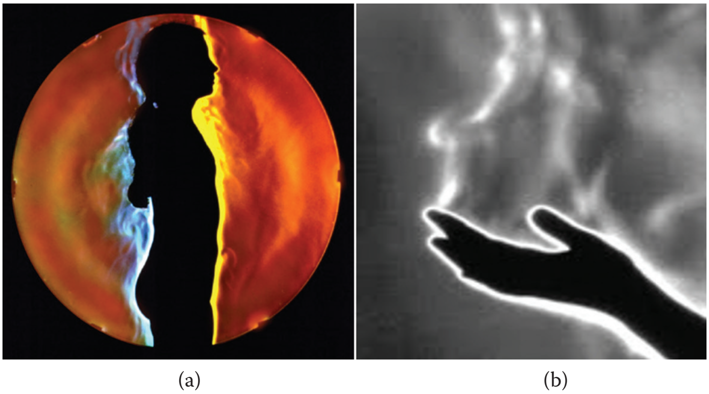


Figure 3.3 Chemical odor profiles from axillary sweat samples. (Data from Curran A.M., 2005, The Analytical Determination of the Uniqueness and Persistence of the Volatile Components of Human Scent Using Optimized Collection Methods, Doctoral dissertation, Florida International University.[20])

			Subject, Sample																											
	R.T.	**Compound Name**	F1, 1	F1, 2	F1, 3	F2, 1	F2, 2	F2, 3	F3, 1	F3, 2	F3, 3	F4, 1	F4, 2	F4, 3	F5, 1	F5, 2	F5, 3	M1, 1	M1, 2	M1, 3	M2, 1	M2, 2	M2, 3	M3, 1	M3, 2	M3, 3	M4, 1	M4, 2	M4, 3	M5, 1	M5, 2	M5, 3
🟦	3.86	Pyridine													x	x	x															
🟥	4.68	2-Butenal, 2-methyl-													x	x	x															
🟨	5.70	Butanoic acid	x	x	x										x	x	x															
⬜	6.50	2-Furancarboxaldehyde	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
🟪	7.20	2-Furanmethanol													x	x	x							x	x	x	x	x	x			
🟥	8.32	Nonane													x	x	x															
🟦	9.03	Propanedioic acid, dimethyl ester																x	x	x										x	x	x
🟪	9.72	Benzaldehyde	x	x	x										x	x	x							x	x	x						
🟧	10.24	Phenol	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
🟪	11.26	Benzyl Alcohol				x	x	x																x	x	x						
🟨	12.37	1,6-Octadien-3-ol, 3,7-dimethyl-																						x	x	x						
🟦	12.38	Undecane																												x	x	x
🟩	12.47	Nonanal	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
🟥	12.82	Octanoic acid, methyl ester																x	x	x	x	x	x									
🟦	13.42	2-Nonenal, (E)-																														
🟦	13.89	2-Decanone	x	x	x										x	x	x				x	x	x									
🟦	14.02	Dodecane	x	x	x							x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
⬜	14.12	Decanal	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
⬛	14.42	Nonanoic acid, methyl ester																x	x	x	x	x	x							x	x	x
⬜	14.76	Hexanedioic acid, dimethyl ester				x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x				x	x	x
🟦	15.49	Tridecane	x	x	x										x	x	x							x	x	x						
🟪	15.62	Tetradecane	x	x	x										x	x	x	x	x	x				x	x	x						
🟪	17.82	5, 9-undecadien-2-one, 6, 10-dimethyl	x	x	x	x	x	x							x	x	x	x	x	x	x	x	x	x	x	x						
🟧	18.87	Dodecanoic acid													x	x	x															

Figure 3.5 Set of 24 primary odor compounds used for sample discrimination. (Reprinted from Curran, A.M. et al., 2010, *Journal of Forensic Sciences*, 55, 53.[22] With permission from Elsevier.)



(a) (b)

Figure 4.2 Schlieren images of the thermal plume of (a) an 11-year-old girl, (b) palm up. (Photos courtesy of Professor Gary Settles, Distinguished Professor of Mechanical Engineering, Penn State University, University Park, State College, Pennsylvania.)

Figure 4.4 Canine scent searches under various terrain features in the United States and Argentina. (Photos courtesy of Paola A. Prada, Curtis Fish, and Dr. Mario R. Rosillo.)

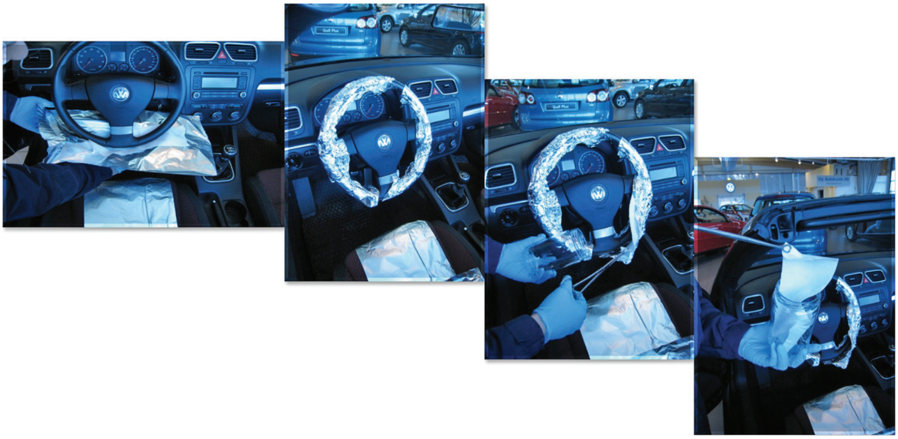


Figure 5.2 Passive contact collection from a steering wheel, Finland. (Photos courtesy of Ilkka Hormila, Police Dog Training Center, Hämeenlinna, Finland.)

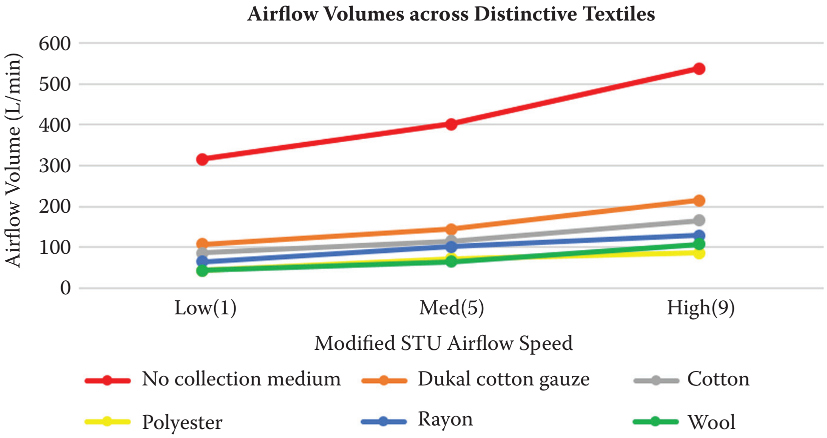


Figure 5.5 Airflow volume measurements across different collection materials. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[4] With permission.)

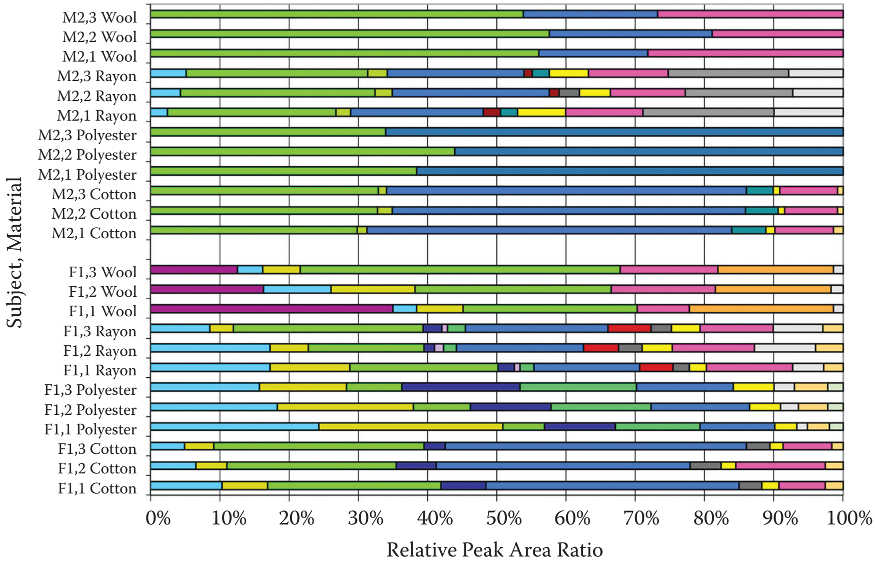


Figure 5.8 Color odor chart for a female and male subject, primary odor per fiber type. (Reprinted from Prada P.A. et al., 2011, *Journal of Forensic Sciences*, 56, 878.[12] With permission from John Wiley & Sons.)

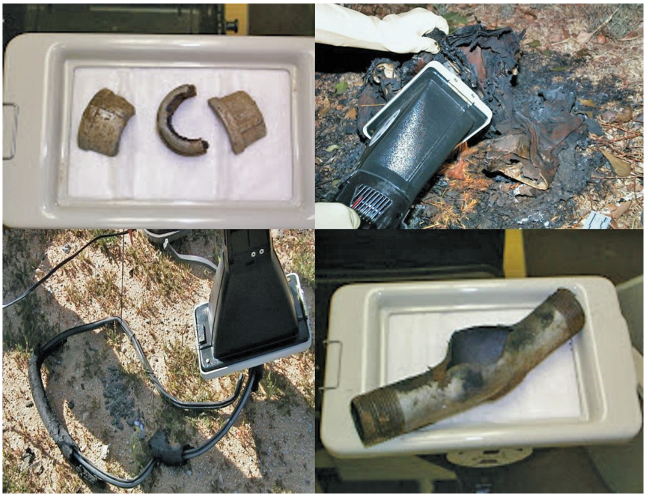


Figure 6.1 An STU-100 scent collection from a detonated bomb and arson evidence. (Photos courtesy of William Kift.)

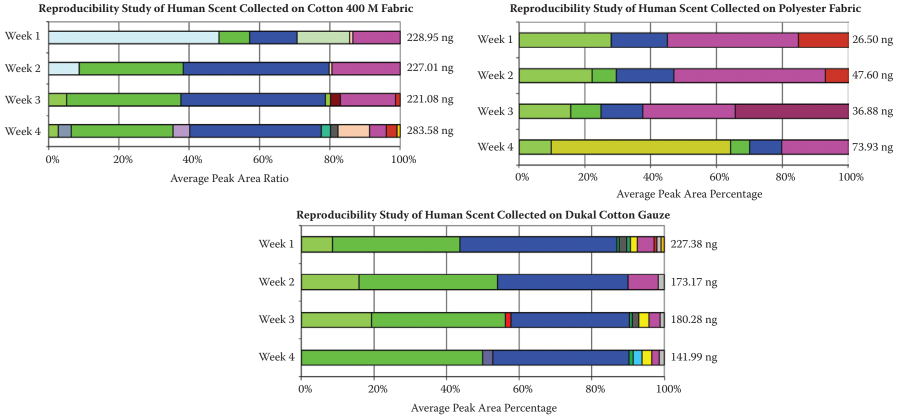


Figure 6.4 Reproducibility study of collected hand odor from a female subject on three different sorbent materials. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[10] With permission.)

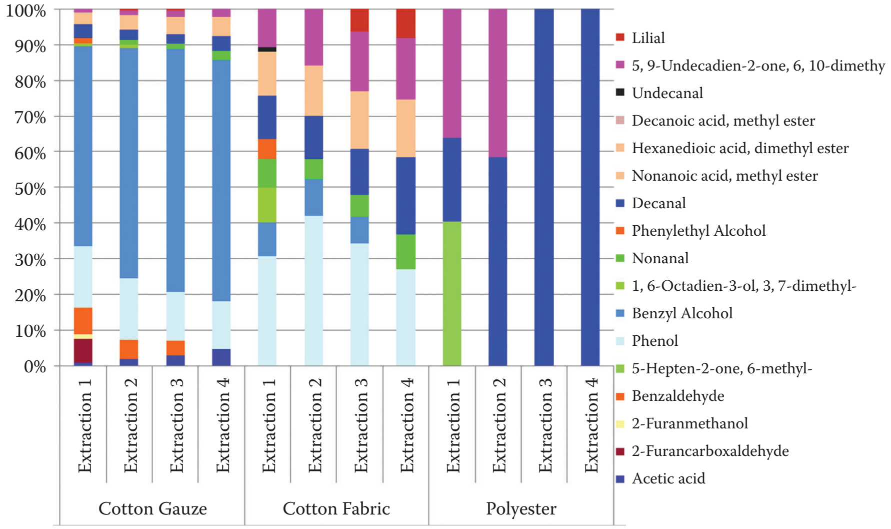
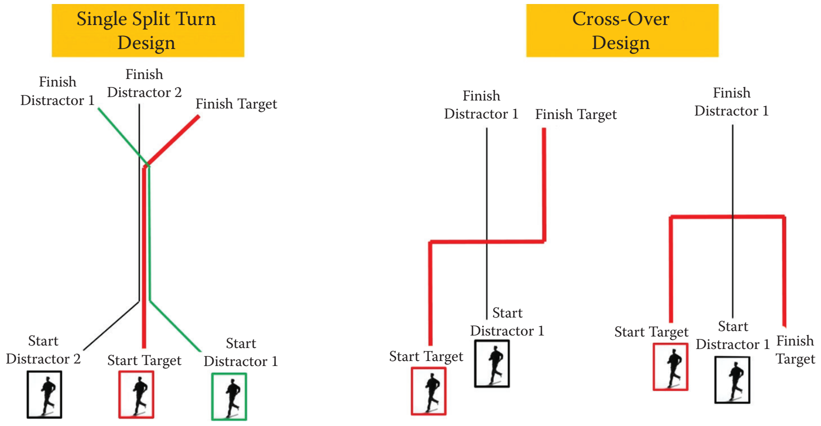


Figure 6.5 Stability of human hand odor for a female subject. (From Prada P.A., 2010, Evaluation of Contact and Non-Contact Trapping Efficiencies of Human Scent Chemical Profiles and Their Stabilities under Different Environmental Conditions, Doctoral dissertation, Florida International University.[10] With permission.)


Single Split Turn Design
Finish Distractor 1
Finish Distractor 2
Finish Target
Start Distractor 2
Start Target
Start Distractor 1
Cross-Over Design
Finish Distractor 1
Finish Target
Finish Distractor 1
Start Distractor 1
Start Target
Start Target
Start Distractor 1
Finish Target

One distractor trail is fresher than target trail, other distractor trail is same age

Distractor trail is fresher than target trail

Figure 7.6 Schematic of SWGDOG recommended track/trail design for odor recognition assessments in last known position searches. (Data adapted from SWGDOG SC9—Human Scent Dogs Tracking/Trailing People Based on Last Known Position (approved by membership 3/3/2010). Miami, FL: Scientific Working Group on Dog and Orthogonal detector Guidelines.[27])

Figure 7.7 Human Remains Canine Team, Colombia National Police. (Photo courtesy of Colonel Mario Chavez.)

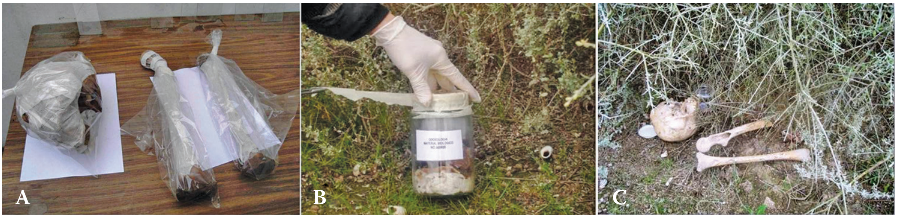


Figure 7.8 Training aid materials: (A) gauze wrapped around human bones, (B) putrefied biological material, (C) human bones on actual surface. (Photos courtesy of Dr. Mario R. Rosillo.)

FORENSICS & CRIMINAL JUSTICE

Human Scent Evidence

During the last decade, a significant number of scientific studies have supported the use of human scent as a biometric tool and indicator of the presence, or absence, of an individual at a crime scene. These findings even extend to conducting scent identification line-ups with suspects. ***Human Scent Evidence*** focuses on some of these recent advances in the use of human scent as forensic evidence and as an identifier. Topics include:

- Various theories of human odor production
- The variability, stability, and persistence of human scent
- Historical aspects of the use of human scent in police work in the United States and internationally
- Current trends in scent collection techniques, including devices, materials, and storage protocols
- Chemical aspects of the evaluation of human scent, including instrumental methods for odor detection and analysis
- The legal significance of human scent evidence results
- Canine scent work from multiple search categories as described in the Scientific Working Group on Dog and Orthogonal detector Guidelines (SWGDOG)

Human scent evidence may be of critical use in many cases where other types of evidence such as DNA, fingerprints, or fibers are not readily available. As such, it can be a valuable tool in forensic investigations. With examples from North and South America and Europe, this book draws upon an extensive literature review of past and current research and is enhanced with findings from the authors' own research. It concludes with a glimpse of the future direction of human scent evidence in the forensic field and its application as a biometric and diagnostic tool.

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